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ABSTRACT

This document is a working paper designed to point up some policies for the training of staff for the graduate schools in the universities in Ontario. Over the past few years, graduate enrollment has increased greatly, primarily a result of increased government funds for the expansion of graduate education. Recently, however, a scare has been in effect, that has caused many persons to decide that too many persons are being educated at the graduate level for the manpower demands. At this point, the Ontario government cut back on funds, hoping to curtail the problem of over-education. Presented here are: problems in forecasting requirements for academic staff and using analytic models for supply/demand comparisons; an illustration of the use of a model for analyzing Ph.D. enrollment alternatives; and principles and suggested policies for graduate enrollment and financial support. (HS)

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Council of Ontario Universites
Conseil des Universités de l'Ontario

Graduate Enrolments in Relation to Requirements for Academic Staff in Ontario Universities

Brief to the
Ontario Committee on University Affairs

71 — 14

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Introduction

Graduate work in the Province of Ontario has developed remarkably in the past nine years because of the government's Province of Ontario Graduate Fellowship programme. This support hastened the growth in numbers, size and quality of the graduate schools in Ontario universities and helped to redress an imbalance between Canada and the United States which had resulted in many Canadians being almost obliged to go to American graduate schools - or overseas - for advanced studies.

Some months ago, concern was voiced about an overproduction of persons with graduate degrees. This concern reached a crescendo with the publication of a survey done for the Economic Council of Canada, along with many articles and speeches. The effect of all this was to dampen the interest in graduate work on the part of many graduate students; also there was a scare effect, inducing people who already had jobs to hang on to them. Added to this was the Ontario Government's cutback in the amount for graduate fellowships, and the new regulations limiting the permissible amount of earnings by graduate students. The total effect was powerful enough, as is now generally known to cause a substantial reduction both in the numbers seeking admission to the graduate schools and in the numbers continuing their studies to the highest level.

There are now different schools of thought about what the future holds; some believe that still further restrictive measures are necessary; others, that the self-regulating effect is already so strong that we must take care not to go too far in the other direction and stifle the development of people who will be much needed in the society of the future.

It has been a practice recently to employ models to assist in forecasting situations that might come to pass. This is a useful exercise and will become more common. But modelling is still in the early stages of development and refinement; it is a primitive device in the university environment. Models, to be effective, must be based on as complete and accurate a set of assumptions as can be established. Some models are misleading through being based on the historical trends of the past; because they are based on essentially static conditions they are not helpful in a changing situation. The hazards of relying too heavily on such static models are demonstrated by the three patterns which are outlined in the present study (Part 2), which show that slightly changed assumptions can produce significantly different pictures of the supply/demand relation.

In some other models that have been created, a static employment situation is assumed which we believe distorts the whole question. We all know the condition of society is anything but static. One such assumption is that the chief or only employers of PhDs are universities.

In the post-industrial world whose problems are much more complex, it may well be true that the PhD is rapidly becoming comparable to the nineteenth-century Oxford B.A. as an appropriate background for responsible work in business, industry, the civil service, municipal office, and areas of planning, administration and environmental control presently unknown, as well as teaching and research. Indications that this may be the case are, first, the tendency to broaden advanced work and produce more adaptable people; second, the phenomenal growth of interdisciplinary approaches and the emphasis on synthesis as distinct from specialization, and third, the non-university employment patterns in the United States where the development of graduate work on a large scale took place earlier. If we consider the whole situation, the demand for the products of our graduate schools is likely not to suggest any drastic curtailment on our graduate schools' production of these people at the present time. This kind of assumption should be tried out in any modelling we do.

This, then, is not a document of ours that we are here to defend to the last comma. It is a working paper which it is hoped will help CUA and COU to achieve a thorough appreciation of the complexity of the situation that we are studying, and point to some policies for the best interests of society including training for and staffing the universities in the system.

Part 1

Problems in Forecasting Requirements for Academic Staff and Using Analytic Models for Supply/Demand Comparisons

Uncertainties in Forecasting Demand

Opinions about the desirability of forecasting the demand for highly qualified manpower range from the one extreme of complete laissez faire to the other extreme of forecasting the demand for PhDs in microbiology in the year 1983 and setting enrolment policy limits accordingly. There are various opinions that lie in between, including one that deserves some attention, namely, that the upward movement in the demand for highly qualified manpower is directly related to the shift from private to public expenditures. Given the considerable interchangeability of advanced academic preparation for different occupations (and most observers think substitution will need to increase rather than abate) it seems futile and costly to attempt manpower forecasting at a low level of detail. How then can the decision-makers at all levels properly assess what resources should go to what purposes, when and for how long? This is the basic financial logistics problem that must be faced. More importantly, when we make such decisions as limiting PhD enrolment intakes and levels the maximum impacts of these decisions will be felt an average of 4-5 years later. We are now experiencing in North America the impacts of decisions made in the early 60's to upgrade markedly the level and quality of scientific, research-based university education coincident with expanding opportunity for access to higher education. If there is a surplus problem of the dimensions estimated by Alan Cartter for the United States because of the decisions made in the late 50's and early 60's, will we have a shortage problem in 1980 because of restrictive policies we are contemplating now?

Having said all this, the decisions must still be made because of the simple fact that we are faced with limited resources, there are competitors for these resources (for example, health, welfare, highways, etc. in addition to education) and it is necessary to apportion the resources among these sectors over both the short term and the long term. A decision to allocate a portion to one sector means that the other sectors are left with the remainder. Government must make the choices about what portions are allocated to each major sector. And in the face of public pressure, it cannot opt out completely from the decision of how much is allocated to graduate vs undergraduate within the university sector of the education sector. How should the resources allocated to the university be distributed between graduate education and undergraduate education?

Policy is not completely clear to us at the present time but it appears that government, by direct and indirect measures, is moving progressively further into the decision level concerned with the mix of allocation of resources to graduate and undergraduate programmes. For example, graduate scholarship support has been reduced yet we are adjured to maintain excellence. The open door policy is maintained and reinforced in the face of declining increases in revenue. Changes in policies which affect graduate/undergraduate mix, reductions in financial support, and pessimistic occupational outlooks all have impact not only on our ability to forecast demand but also on the demand itself and on the supply to meet that demand.

It appears to us there is a need for clearly-understood statements of purpose for these moves by government and at the same time some understanding of our problems in trying to plan for resources and forecast demands for the long-term in the face of short-term changes in policy and priorities.

There are other limitations to forecasting demand. Interchangeability is a potentially important variable. We hold out hope that the academic staff of the future will be somewhat less committed to narrow fields and more open to crossing current disciplinary classification barriers. This, of course, implies the possibility of a changed doctorate or the provision of mid-course correction points where the changed occupational outlooks could be evaluated by the student and he could make the decision to proceed along the original course or adopt a new one. In simplest terms, if the teaching resources are highly interchangeable the data can be evaluated at a much more aggregative level.

Other important variables are international, interprovincial and intersectoral flows of highly qualified manpower; retirement, mortality, and intersectoral transfer rates, incremental student to staff ratio for the projection period and universities' PhD consumption ratio.

Limitations of Analytic Models in the Absence of Certainty

An analytic model has been developed in the COU Research Division to compare the supply of PhDs to the demand for them using differing values for important parameters. A simplified example of how the model operates is included as Part 2 of this brief. Three scenarios are presented using alternative yet reasonable values for the parameters. The results are shown in Tables 2.1, 2.2, and 2.3 with the parameter values that have been used. Models such as the one shown in Part 2 can be very useful if they are used properly. Their utility is, of course, limited to their capability to represent the real world. We have found in the development of the model that there is a real problem with data - that data that do exist must necessarily be historical and therefore not necessarily representative of the future, and we are forced to make assumptions about what future values of the important variables might be. (Appendix 2 shows very vividly how limited we are by data and the necessity to make assumptions.) That is the reason for showing a range of possible outcomes given the values assigned to the parameters of the model. There is another limitation that we may not have included all of the parameters that should have been included. Also, use of a model at the provincial level may require a greater degree of assumption than is merited. (Existence of outflows and inflows makes analysis at the national level essential. Any reductions in the assumptions we are forced to make because of limited information on flows will yield corresponding accuracy in results.) We stress that our ultimate aim should be to deal with these types of problems nationally. We would also stress that such models,

though they are micro-analytic in form, should be used for analysis of macro-planning alternatives. If highly qualified manpower is produced over lead times of five years, then increments to the stock, if planned at all, should not be planned year by year. And with such long lead times there will not be, nor should there be, a precise-matching of supply and demand.

We wish to stress the point that the surpluses or deficits that show up in such analyses may simply be reflecting the normal operation of this type of market. It follows then that the goal should not be balancing of supply and demand year by year or necessarily even every five years. The market has been highly inflated over the past ten years. Is it necessarily wrong that it should deflate normally over the next five years?

Considering the traditional difficulties Canada has had with producing and retaining highly-qualified manpower it is just possible that a "surplus", if this is what is indicated by a particular pattern, is not a surplus in the real sense but a reservoir of talent which should be allocated to the many problems of a public policy nature facing our Canadian society. In any case the model is available for more extensive analysis using alternative parameter values. We expect to be able to get a good deal of utility out of this model in the evaluation of alternative courses of action. We invite CUA to join with us in refining this model where it needs refinement, and then using it for analyzing alternative policies.

Conclusions Arising from the COU Conference on Supply and Demand

We note here that the summary of the supply and demand conference (included in this brief as Appendix 1) recommends that the technical experts concerned with modelling and analysis should convene after enrolment information for 1971-72 is available. They should resolve any serious disagreements on parameter values and subsequently provide policy-makers with their forecasts of supply and demand.

At this conference it was emphasized that there are indications that the market is operating. There are indeed marked reductions in the intake of PhD seekers. The specific question was raised of whether or not there should be any dampening action on specific programme enrolments with the consensus response favouring (1) give the market signals time to have their normal effects, (2) publicize and distribute information about employment prospects and requirements as widely as possible, (3) evaluate very carefully for their impacts any plans to use controls and steering incentives for application by various authorities (granting agencies, provincial governments, universities) to various instruments (student aid reductions, outright restrictions on enrolments, closing of programmes, quotas on non-Canadians, etc.) and (4) do not recommend specific restraint measures at least until the enrolment figures for 1971-72 are available and analyzed for their long term implications. There was great concern expressed that we would overreact in the short term and intensify the normal imbalances that characterize the supply and demand of highly qualified manpower.

Appendix 3, showing employment of students awarded PhDs in Canada in 1970-71, is attached to give some emphasis to our plea not to over-react too quickly to alarmist reports. More detailed information is available in the report itself but we would mention here that out of 1300 PhDs awarded in Canada in 1970-71 only 72 showed immediate unemployment after graduation. This is about the general level of unemployment in the country.

Difficulties in Finding Highly-Qualified Canadian Staff

With respect to the continuing concern for the non-Canadian content of our academic staff we have reviewed the sections of the briefs of the universities to CUA setting forth the difficulties of finding qualified university staff. A fair composite summary of their comments would be that while there is now an adequate supply of junior Canadian staff in most disciplines, the recruitment of experienced senior academics for teaching, research and administrative positions remains difficult due to a shortage of suitable Canadian candidates. The situation seems to be far more acute in the Social and Health Sciences than in Humanities, Physical Sciences or Engineering.

In Humanities, junior staff are readily available but senior staff are much more difficult to find. There are shortages of Canadian staff in Anthropology. Overall the situation is considered to be good in Humanities.

In Social Sciences, however, not only is there a dearth of highly qualified and experienced senior academics but it is very difficult to find even junior staff in disciplines such as Business Education and Physical Education. At the senior level, shortages of adequately qualified Canadian staff in Sociology, Economics, Psychology, and Geography are consistently reported by Ontario universities.

There is broad agreement that an adequate supply of both junior and senior Canadian staff is available in science disciplines except in the areas of Information and Computer Science and Applied Statistics.

In Engineering, the situation is similar to that of Science, although there appears to be some difficulty in obtaining staff with extensive industrial and/or research experience.

Finally, in the Health Sciences, there is great difficulty in obtaining suitable Canadian staff at both junior and senior levels due partly to the fact that there is little or no graduate training in Canada in many areas of Health Science and partly to the very specialized natur of training demanded. Some of the most frequently cited areas are Clinical Pharmacology and Epidemiology, many areas of Graduate Nursing, Psychiatry, Physical Medicine and Rehabilitation and several Dental and other Medical Specialties.

We would also note the comments of H. J. Somers, Executive Director of the Association of Atlantic Universities in a letter to G. C. Andrew May 21, 1971 that at a meeting of the presidents of universities in the Atlantic region not one could report a surplus of applications from Canadian PhDs. All agreed there was still a shortage in the social sciences. Difficulty existed in most areas for francophone institutions. All reported that they were flooded with applications from the United States.

Part 2

Illustration of the Use of a Model for Analyzing PhD Enrolment Alternatives

An example of the application of the model will be carried through to show how it works. For ease of illustration and interpretation this example is limited to one year and a chosen set of parameter values. No significance therefore should be attached to the outcome. The model itself is capable of analyzing multi-year data and provides for estimating supply and demand by major disciplinary grouping.

Demand Calculations

The model derives several estimates of the demand for academic staff on the assumption that total and incremental student/staff ratios will remain nearly constant during the projection period. Thus, the number of FTE students expected in each year of the projection period is divided by the average FTE student/FT staff ratio over the last four years to give the required number of staff in each year as shown below.

$$\text{Staff}_x = \text{Students}_x \div \text{SS ratio} \qquad (1)$$

If we put x = 71-72 and use actual data summing over all discipline groupings

$$\text{Staff}_{71\text{-}72} = 137{,}200 \div 16.4 = 8{,}366$$

The demand for academic staff by major discipline grouping is then obtained by applying to the estimate of total demand a percentage distribution which is itself based on recent trends in the present distribution of total academic staff among major discipline groupings. By subtracting each year's staff requirements from that of the preceding year for each discipline grouping and allowing for deaths and retirements, we obtain an estimate of the demand for full-time academic staff in each year of the projection period. For each discipline group,

$$\text{Additional staff}_x = \text{Staff}_x - \text{Staff}_{x-1} + \text{Attrition replacements}_{x-1} \qquad (2)$$

For x = 71-72 and over all discipline groups

$$\text{Additional staff}_{71\text{-}72} = 8{,}366 - 7{,}606 + 293 = 1053$$

An alternative estimate of the number of additional full-time academic staff required in each year may be obtained by dividing the expected increases in FTE student enrolment in each year of the projection period by the incremental FTE student/FT staff ratio over the last four years. Thus, for each discipline group,

$$\text{Additional Staff}_x = [(\text{Students}_x - \text{Students}_{x-1}) \div \text{Incremental SS ratio}] + \text{Additional Replacements}_{x-1} \quad (3)$$

Using x = 71-72 and actual data over all discipline groups

$$\text{Additional Staff}_{71-72} = 12,470 \div 20.0 + 267 = 890$$

Assumptions are made about the percentage of new staff holding PhDs and the number of such staff positions available for Canadians to generate an estimate of demand for academic staff with PhDs in Ontario during the projection period. Thus, for each discipline group,

$$\text{PhD demand}_x = \text{PhD \%} \times \text{Canadian \%} \times \text{Additional Staff}_x \quad (4)$$

i.e.

$$\text{PhD demand}_x = \text{PhD\%} \times \text{Canadian \%} \times [(\text{Students}_x - \text{Students}_{x-1}) \div \text{SS ratio} + \text{Attrition replacements}_{x-1}] \quad (5)$$

For x = 71-72 and using the incremental method over all discipline groups

$$\text{PhD demand}_{71-72} = .73 \times .68 \times 890 = 442$$

Supply Calculations

To estimate supply of academic staff with PhDs during the projection period the production of Ontario PhDs by discipline grouping is first estimated. This is accomplished by deriving the intake of PhDs by discipline grouping for the period 1968-69 to 1971-72 from PhD enrolment data and graduations during the corresponding period using the following formula. For each discipline group,

$$\text{Enrolment}_x = \text{Enrolment}_{x-1} - \text{Graduations}_{x-1} + \text{PhD intake}_x - \text{Dropouts}_{x-1}$$

We have data for enrolments and graduations and we have been able to estimate the dropouts in each year by a recursion formula using a simple model of the PhD graduation process. Using these derived PhD intakes and the mathematical model of the PhD process, an estimate of the number of PhD graduations during the projection period by discipline grouping is obtained. Thus, for each discipline group,

$$\text{Ontario PhD Graduations}_x = \text{Proportion of PhD Intake}_{x-3} + \text{Proportion of PhD Intake}_{x-4} + \text{Proportion of PhD Intake}_{x-5} \quad (6)$$

Using x = 71-72 and over all discipline groupings

$$\text{Ontario PhD Graduations}_{71-72} = .3 \times 1215 + .4 \times 900 + .1 \times 700 = 365 + 360 + 70 = 795$$

Based on such historical data as exists, assumptions about the magnitudes of the flows of PhDs into the Ontario university sector from all other sectors are employed to derive the supply of academic staff with PhDs available to the Ontario university system in each year of the projection period by discipline grouping. Therefore,

$$\text{PhD supply}_x = \text{University share of Ontario PhD Graduations}_x + \text{PhD inflows from other sectors}_x \quad (7)$$

For x = 71-72 and over all discipline groups

$$\text{PhD supply}_{71-72} = .47 \times 795 + 128 = 502$$

Comparisons of the resulting estimates of demand for and the estimates of the supply of academic staff with PhDs for the projection period are then made and estimates of the surplus or deficit for each discipline group are derived.

$$\text{Surplus}_x = \text{PhD supply}_x - \text{PhD demand}_{x+1}$$

For x = 71-72 and over all discipline groups

$$\text{Surplus}_{71-72} = 502 - 442 = 60$$

A simple computer simulation model is available which permits a quick evaluation of any combination of alternative values one might wish to give to the parameters of the model. This model may also be used to indicate the sensitivity of the final result to each of the various assumptions made.

Tables 2.1, 2.2 and 2.3 (Patterns 1, 2 and 3) are three examples of simulations using the parameter values noted below each pattern. For these examples we have held constant the parameter values of 20:1, incremental student/staff ratio, 3.5% attrition replacement rate, Ontario university employment percentage and 60% return rate of Canadians with PhDs and have varied the incremental percentages of PhDs and Canadians to be employed. It will be seen how sensitive the results are to changes in only these two parameters. The overall indicated surplus of 18% for the first assumption changes to a 1% indicated surplus with small upward adjustments and to a 14% deficit with further small upward changes. Either surpluses or deficits can be caused to occur as a result of assumptions or policy changes. If, for various reasons, Pattern 1 were to become a reality, it might be a perfectly healthy and normal pattern especially in view of the uncertainties in estimating future values for important policy and data variables. On the other hand, if greater proportions of Canadians and PhDs were to be hired then either of Patterns 2 or 3 could represent reality.

It is evident, in very stark terms, how dependent results are upon policies taken now and the effects of market signals to students about occupational outlooks. We have not shown other simulations that we have performed which yield other results. From the limited experimentation we have done so far, the ratio of returning Canadians, the incremental student to staff ratio, and intersectoral flow rates are sensitive parameters, i.e., alteration of their values produces significant changes in results. Others seem to be less sensitive but combined together, they too could produce significantly different results. With regard to further refinement, we need particularly to examine the flow rates and returning Canadian ratios more carefully taking into account all possible data. Even allowing for changes in enrolment trends and in policies which affect enrolment and staffing, we cannot place much faith in any indicated surplus or deficit until we have made these refinements.

The changing pattern over the years is very important. Taking Table 2.1 for example - the pattern from year to year implies that we have emerged from a deficit condition, will reach peak surplus in 1973-74, and will have declining surpluses for the rest of the projection period. This reinforces our contention that oscillating effects in the supply and demand of highly qualified manpower over multi-year periods are to be expected and are completely normal.

PATTERN 1

The surplus (deficit) of PhDs available to the Ontario university system based on COU's supply estimate and the OISE demand estimate (incremental)

Year	Humanities	Social Sciences	Biological Sciences	Physical Sciences	Total
1971-72	53	(49)	9	47	60
1972-73	112	(8)	10	65	178
1973-74	124	4	9	47	183
1974-75	108	33	2	4	147
1975-76	67	(5)	(7)	(15)	40
1976-77	19	(93)	1	17	(57)
Surplus Total 1971-76	483	(118)	24	165	551
Demand Total 1972-77	720	1089	293	1008	3110
Surplus as a % of demand	67%	(11%)	8%	16%	18%
Parameter values					
a) 20.0:1 incremental student/staff ratio					
b) 3.5% attrition replacement rate					
c) PhD Increment (%)	60%	65%	90%	95%	73%*
d) Canadian Increment (%)	60%	70%	80%	70%	68%*
e) Ontario university employment (%)	67%	58%	34%	38%	47%
f) A 60% return rate for Canadian PhDs					

*Based on weighted 1971-72 demand projections.

TABLE 2.1

PATTERN 2

The surplus (deficit) of PhDs available to the Ontario university system based on COU's supply estimate and the OISE demand estimate (incremental)

Year	Humanities	Social Sciences	Biological Sciences	Physical Sciences	Total
1971-72	17	(72)	9	37	(10)
1972-73	73	(33)	10	54	104
1973-74	79	(25)	9	34	97
1974-75	63	4	2	(8)	60
1975-76	20	(35)	(7)	(28)	(50)
1976-77	(30)	(124)	1	4	(149)
Surplus Total 1971-76	222	(285)	24	93	52
Demand Total 1972-77	980	1256	293	1080	3609
Surplus as a % of demand	23%	(23%)	8%	9%	1%
Parameter values					
a) 20.0:1 incremental student/staff ratio					
b) 3.5% attrition replacement rate					
c) PhD Increment (%)	70%	70%	90%	95%	78%*
d) Canadian Increment (%)	70%	75%	80%	75%	74%*
e) Ontario university employment (%)	67%	58%	34%	38%	47%
f) A 60% return rate for Canadian PhDs					

*Based on weighted 1971-72 demand projections

TABLE 2.2

PATTERN 3

The surplus (deficit) of PhDs available to the Ontario university system based on COU's supply estimate and the OISE demand estimate (incremental)

Year	Humanities	Social Sciences	Biological Sciences	Physical Sciences	Total
1971-72	(26)	(110)	9	26	(101)
1972-73	28	(74)	10	43	7
1973-74	27	(72)	9	22	(14)
1974-75	11	(44)	2	(20)	(52)
1975-76	(34)	(85)	(7)	(40)	(166)
1976-77	(86)	(176)	1	(9)	(270)
Surplus Total 1971-76	(80)	(561)	24	22	(596)
Demand Total 1972-77	1280	1531	293	1152	4256
Surplus as a % of demand	(6%)	(37%)	8%	2%	(14%)
Parameter values					
a) 20.0:1 incremental student/staff ratio					
b) 3.5% attrition replacement rate					
c) PhD Increment (%)	80%	80%	90%	95%	84%*
d) Canadian Increment (%)	80%	80%	80%	80%	80%*
e) Ontario university employment (%)	67%	58%	34%	38%	47%
f) A 60% return rate for Canadian PhDs					

*Based on weighted 1971-72 demand projections.

TABLE 2.3

Part 3

Principles and Suggested Policies for Graduate Enrolment and Financial Support

We have emphasized the need to keep in mind the limitations of exercises in forecasting the employment market for holders of graduate degrees, but we nonetheless realize that they constitute one essential factor in the development of the government's policy for graduate education. The level of governmental support for graduate studies should also be determined in the light of additional considerations which are not directly related to vocational preparation: the cultural needs of the individual and of society, the career flexibility of well-educated people, the merits of a leavening of such people in all walks of life. None of these comments should be taken to mean that COU questions the need for enunciated public policy in this field; on the contrary, COU is, of course, sponsoring the extensive series of discipline planning assessments which are intended, amongst other important results, to lead to carefully considered figures indicating the desirable magnitude of Ontario's graduate effort, discipline by discipline.

We believe that certain principles should govern the development and application of policy, both now and as the various planning assessments begin to come to fruition. These principles follow from the uncertainty of forecasting, from the long lead time between introduction of a policy and its actual influence on numbers graduating, from the resultant danger that large oscillations in future numbers may result from apparently small perturbations in policy. These principles can be listed as follows:

(a) The government should be primarily concerned with the overall provincial scale of financial support for graduate work, not with details of the distribution of the activity amongst the universities. It is, however, properly concerned to see that the universities are achieving this distribution in a responsible way, leading to a provincial system of graduate studies where work of high quality is encouraged.

(b) The government should be concerned with the amount of support for graduate students which it should provide, but not with the absolute number of students. In other words, if students or institutions choose to engage in graduate work without provincial fellowships, that should be recognized as their prerogative. The government should be concerned that the students for which it does supply support are of good quality.

(c) Government should avoid heavy-handed measures if it chooses to decrease or increase the flow of support for graduate studies. Sharp fluctuations are likely to produce damaging long-term effects. The system does respond to changes in levels of support, as the enrolment for 1971-72 illustrates. From the position of steady growth in previous years, the M.A. (enrolment intake) in Humanities fell this year from its previous value by about 17% and in Social Sciences by about 8%. In some measure, this was a response to the cuts in financial support introduced this year for new students in these disciplines.

(d) Forecasts and the results of the regular reviews should be publicized so that individuals and individual institutions can consider their responses to the trends. A very considerable measure of the free play of competitive decision-making is an important component of a healthy system, but such activity should be carried on with as much information as possible.

(e) Forecasts need regular re-examination, preferably annually. In other words, both the employment market and the enrolment patterns need to be under constant review. If forecasts are to be of real value they should be national rather than only provincial.

We would now like to suggest certain kinds of policies which follow from these principles.

(a) In the first place, the government should settle on an overall number of graduate students for whom it is prepared to provide support. We indicated above some of the factors to be considered in arriving at such numbers, which must, of course, be generated cumulatively, i.e., proceeding from an analysis of needs in the various disciplines. One might contemplate a good deal of rather detailed analysis leading to a plan for development of each discipline's graduate programme in the Ontario universities. Although most persons are aware of the improbability of great precision in such an analysis and they fear that a very detailed plan would be Orwellian in character and would restrict innovation, they realize at the same time that wise and cooperative planning is essential for the further healthy growth of our graduate schools. Detailed discipline-by-discipline assessment and planning on a general scale is under way, but will not begin to produce results for some time. In the meantime, our graduate enrolment in Ontario is determined by several diverse factors: the number of NRC, MRC and Canada Council scholarships, the dollar amount set aside for OGFs, the amounts that can be allocated from professors' research funds for student support, the size and flexibility of competitive offers from other jurisdictions, and the number of students that can be supervised by the teaching staff. Manpower estimates and employment opportunities are a factor only to the extent that prospective students are influenced in their decisions whether or not to enter graduate school by what they perceive to be career opportunities; this regulatory mechanism should not be undervalued.

Graduate work of high quality is essential to the well-being of the Ontario university system. We are unlikely to achieve good graduate departments without effective allocation of resources and responsibilities to various universities. Gradually we will achieve a planned growth pattern, but in the meantime we must seek to make the best possible use of the resources allotted (such as federal and provincial scholarships) even though the allocations may be made in a relatively ad hoc way. It should be noted that the decision to allocate a given amount of money in any year to the OGF programme,

however that decision may be reached, is equivalent in a fairly direct way to controlling graduate enrolment. If no financial support is available, most students will either not undertake graduate work or will leave the province to do it. We believe that our recommendations provide a framework in which the planned development of graduate work in the province can proceed most effectively.

(b) The numbers selected by the government for support might be related in some way to the total number of honours baccalaureates or equivalent being awarded in the province. More precisely, the phrase "honours baccalaureates" would include qualifying students and graduates from other equivalent programmes with sufficient specialization to prepare for graduate work. In this regard particular attention should be directed to the need for graduate work, especially master's level, in some professional fields.

(c) Since employment forecasts are one significant factor in arriving at the numbers, it is essential to consider total projected demand from all sectors: educational institutions, business and industry and government - not just university teaching. Preparation of forecasts should be the responsibility of a federal agency. The Government of Ontario and COU should urge on the Federal Government the importance of this task and the need for federal action.

(d) As at present, the support should be provided to both students and the institutions where they are enrolled. The number of students generating institutional support will be greater than the number receiving direct provincial fellowship and bursary monies, since there are alternative sources of support for some of the students as individuals.

(e) Student support should not be looked on as student aid but as scholarships necessary to attract the best students to Ontario universities. The scholarship support should be of such an amount that most students will welcome the opportunity to earn extra money as teaching assistants, in amounts consistent with their status as full-time students. We believe that graduate work of high calibre benefits the society in which it takes place and that, in the absence of adequate financial support, many potentially valuable members of society, who have reached the age of financial independence, will not choose to enter graduate school at the cost of an immediate financial sacrifice and in the expectation of dubious monetary returns in the future. From the reports presented at the November 1971 meeting of the Canadian Association of Graduate Schools, it is evident that Ontario is no longer in the forefront as far as graduate student support is concerned. It appears that the 1971-72 maximum levels of generally available support in both the western and the maritime regions are somewhat higher than in Ontario. In this respect it should be noted that the introduction of the Ontario Graduate Fellowship Program enabled a number of graduate programmes in Ontario to reach national and even international recognition, this recognition being associated mainly with the ability to attract students with very high scholarly potential. The significance

of a provincial fellowship programme becomes all the more striking if we keep in mind that we are now barely competitive with other jurisdictions in attracting good students.

(f) We reiterate the COU recommendation that the bulk of the scholarship support should be awarded on the basis of provincial competition to the best students. A proportion of awards should be reserved for approved new programmes and emerging programmes.[1]

(g) Allocation of scholarships should apply only to broad groups of disciplines in the province as a whole. They should not, in general, apply to individual universities. The student who has been awarded a scholarship should be free to select the university of his choice. The competition should, of course, be on academic grounds - the nature and quality of the programme offered.

(h) As discipline planning assessments proceed, provincial allocations gradually can be refined to apply to groups of disciplines where recommendations have been made concerning the numbers that should be enrolled.

(i) Scholarship allocations, both for total graduate support and for support by grouping of disciplines, should be updated annually on the basis of updated demand projections. On the basis of present level of support and criteria of academic excellence, we believe that the number of students in the Humanities and Social Sciences to be supported by provincial fellowships in 1972-73 should remain at 1500.

(j) The above policies suggest establishment of a new form of fellowship competition in lieu of the OGF Program. We believe that this could not now be introduced for 1972-73 without great confusion. Already last year's "braking mechanism" has had a deeply disturbing effect. Emergency measures, which in most cases could be applied only for one year not repeated a second year, had to be introduced by the universities to take care of the many students already in programmes in the system. Research grants have had to be drained; free funds have had to be found. Moreover, it must be recognized that what affects the graduate school will ultimately affect the undergraduate faculties. Reductions in graduate enrolment will eventually reduce both the number and the quality of students available for demonstrating and assisting in undergraduate programmes. Genuine competition which allows the best students to seek the best programmes could be introduced in 1973-74. Competition of this kind, favouring quality, would not be biased against new programmes; indeed it seems likely that some established programmes, failing to compete, would not long survive.

COU would, therefore, propose that any new scheme contemplated should be introduced for the 1973-74 academic year and that for 1972-73 the OGF Program continue unchanged.

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[1] Report to the Ontario Council on Graduate Studies of the Committee on Student Financial Support, August 1970, p. 20.

Appendix 1

A Summary of the COU-sponsored Conference
on Academic Staff Supply and Demand

During the summer of 1971, COU convened a two-day meeting to discuss the problems of matching potential supplies of personnel qualified for academic positions with the demand for such highly qualified personnel over the next several years. Guests were invited from various interested provincial and federal agencies and the programme featured presentations on such topics as current and projected employment of PhDs, demands for scientific manpower over the next 10-15 years, and analytic models for forecasting, analyzing and presenting various alternative patterns of supply and demand according to postulated changes in important parameters.

Alan M. Cartter, Chancellor of New York University, was a special invited guest. Dr. Cartter presented a generally pessimistic picture of employment prospects in universities for PhD holders during the next 15 years. He has looked at various projections of college age populations and participation rates, the anticipated outputs of PhD holders from U.S. universities and using present quality standards (proportion of PhDs) and even improving them as a variant in the analysis, he concluded that there could be as many as 100,000-200,000 PhD holders surplus to university staffing requirements during the next decade. Other U.S. studies have tended to confirm his analyses with various interpretations placed upon what effects such a surplus will have on the job prospects and starting salaries of these people, and what it will mean in the displacement of less-educated people from their normal positions in the labour force. Canadian speakers at the conference were less pessimistic about Canadian surpluses. The same problem is recognized but it is not of the same magnitude. Dr. F. Kelly and Dr. A. Boyd, science advisors to the Science Council of Canada, discussed their studies of prospects for employment of scientists and engineers in Canada. Dr. M.A. Preston, Executive Vice-Chairman of the Advisory Committee on Academic Planning, presented information on the employment of students awarded PhDs in 1970-71. Dr. Max von Zur-Muehlen, Economic Council of Canada, and Mr. B.L. Hansen of the Council of Ontario Universities discussed the use of analytic models for demand and supply studies of Canadian PhDs. Mr. Peter Ross, Canada Department of Manpower and Immigration, discussed his studies on the short-run PhD outlook.

After these presentations there was considerable discussion of what further research and refinements to present research were necessary. The possibility of developing manpower policies which would restrain enrolments was given a thorough airing. The main conclusions arising out of the conference are summarized below.

Analytic models for forecasting supply and demand

Planners need to have more disaggregation of university disciplines to be able to use models for effective planning. Present estimates of surpluses and deficits at aggregated levels such as Humanities, Social Sciences, Biological Sciences and Physical Sciences are valuable for general conclusions on present status and for avoiding excessive restrictive measures born out of panic, but they are of limited usefulness for planning additions and replacements of highly qualified specialized manpower.

There is a need for better information on the interprovincial flows of persons taking academic positions in the provincial universities. Also, changing patterns of emigration and immigration between Canada, the U.S. and Great Britain particularly should be accounted for in the models.

Values used for certain parameters in the models need to be examined very closely for their reasonableness as representative values which may be expected to apply over the projection period (e.g. the difference between attrition rates of 2% and 4% does not appear large but it is in numbers of staff when the present and projected complement of staff numbers is in the thousands - 2% of 10,000 = 200. Also, regarding this same parameter of attrition rate, it would be important to input the different attrition rates which would be representative of different discipline groups having different age averages). Other important parameters for tests of reasonableness are incremental student/staff ratios, percentages of new staff with PhDs, lagged baccalaureate to PhD ratios, and lead times for production of PhDs from the baccalaureate.

As a follow-up to this conference, technical experts concerned with modelling and analysis should convene at an early time (immediately after the enrolment information for 1971-72 is available) to resolve any serious disagreements on parameter values and to provide policy makers with their forecasts of supply and demand. Such forecasts are going to have to reach much farther into the future than 1975-76; output prior to 1976 is largely determined by graduate enrolment policy decisions made several years ago (the average elapsed time to completion of a PhD from the baccalaureate being 7-8 years). Their analyses should include the most appropriate disaggregation of disciplines for meaningful comparisons of supply and demand. The survey of graduate students to be conducted during the fall of 1971 by the Canada Council, the Medical Research Council, and the National Research Council, should provide valuable input to the formation of the proper taxonomical structure.

Some means should be found for getting recurring information on employment related to degree programme similar to that provided in the Manpower and Immigration survey of 1967. The data base could be improved also by providing information regularly on the number of new students entering graduate degree programmes.

Discussion related to graduate enrolment policies

There was a great deal of discussion about whether specific measures to restrict enrolment in specific programmes should be recommended. The point was emphasized that there are indications now that the market is operating. There are likely to be marked reductions in the forecasted intake of PhD seekers in the humanities and social sciences (aided, no doubt, by the reductions in provincial student aid support to these disciplines). New enrolments in Chemistry and Physics are expected to be sharply reduced when the enrolment data for 1971-72 are available.

An example on the positive side was cited of 120 applications for geology scholarships this year in contrast to an historical average of 60. In response to a question about whether or not there is a case for dampening actions on specific programmes there was a consensus that (1) the market signals are beginning to have effect, (2) it is important to publicize and distribute information about employment prospects and requirements as widely as possible, (3) effective control cannot rest with any one authority in an essentially open system - if controls are to be introduced the instruments to be used (student aid reductions, outright restrictions on enrolment, closing programmes and employment to non-Canadians, etc.) and the way they are used are very important and (4) specific restraint measures should not be recommended at least until the enrolment figures for 1971-72 are available and analyzed for their long-term implications. There was concern expressed that we would overreact and intensify the imbalances that characterize the supply and demand of highly qualified manpower.

The majority opinion favoured a policy proposed in the Science Council/ Canada Council special study The Role of the Federal Government in Support of Research in Canadian Universities, that

> The country as a whole and the provinces must be concerned about manpower requirements. This concern can be expressed in the first instance through careful survey and forecasting of manpower needs on a continuing basis. Such forecasts should be given wide circulation. It is reasonable to expect that universities will respond by creating additional opportunities for study in the areas of shortage. In addition, the universities through their counselling services have a duty to advise students about the opportunities in various fields from the standpoint not only of intellectual challenge but also of vocational prospects and social utility. The reaction of prospective students to such forecasts is likely to provide an effective control. We believe the market-place, if its trends are made explicit, offers an adequate governor to prevent serious surfeit and to encourage movement of students toward fields of opportunity.[1]

There was dissenting opinion, however, that though we should not overreact as far as controlling total supply is concerned, we should attempt to identify specific areas of extreme surplus or deficit and possibly provide some measures of incentives or control to correct them. It was also pointed out that while the distribution of information on job prospects and openings is improving, it still leaves much to be desired. For example, a check survey had revealed that historically only one out of every six openings for academic positions in Canadian universities was advertised and that as a result of recent public concerns about advertising such positions it had improved to one in three. There is still substantial room for improvement.

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[1] Macdonald, J.B., et al, Ottawa (Queen's Printer 1969), p. 117.

Introduction of changes in the structure of graduate programmes

Several persons commented on the need for more relevant education. For example, if most industrial research is done outside Canada, should education for graduate degrees be concentrated on preparing the person for doing industrial research? It was pointed out that our graduate programmes are too specialized; that there is a need for breadth rather than extreme specialization. It was commented that industry prefers the generalized Master's graduate over the PhD specialist. Our real problem may well be one of over-specialization rather than under-utilization. With respect to the special problem that this presents to the universities, it was pointed out that substitution is the rule rather than the exception for employers in industry. The logistics of transfer of the proper resources at the time needed requires such flexibility. Universities, as employers, can change also. Different kinds of programmes may be needed in the future with different kinds of instructional requirements for different kinds of students. Pupils now coming out of high school may be less willing to accept the lock-step system of streaming directly from high school into university. This, along with other changes occurring in the post-industrial society, implies that our concepts of accessibility to university (who goes and at what time in their lives) may have to undergo some very serious examination. In blunt terms, if universities are to remain marketable, such reassessment is essential.

Problems for university managements

This poses special problems in the management of highly specialized human resources in the universities. The U.S. appears to be heading for deep trouble in the numbers of tenured staff in relation to enrolment, on top of predicted huge surpluses of PhD holders seeking university positions. This is also a problem in Canada, and recent rumblings about the appropriateness of tenure and indications of trends in collective bargaining suggest that university managements are going to have their hands full. In a period of financial restraint new staff are not taken on, surpluses develop, upward mobility is impeded (promotions are shut off) and junior staff become militant. In the absence of specific manpower and immigration policy against entry into the country, university administrators will be faced with very difficult decisions about compromising level of qualification (there may be thousands of PhD holders from prestigious foreign universities applying for Canadian university openings) with the desire to "Canadianize" university faculty in certain sensitive disciplines.

Appendix 2

Application of an Analytic Model for Simulation of PhD Enrolment Alternatives in Ontario Universities (1971-76)

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Council of Ontario Universities,
December 3, 1971.

The difficulties faced by university graduates (PhD holders in particular) in obtaining suitable employment in Canada are receiving more and more public attention. Several investigations have been made into the present employment prospects for graduates, invariably with very gloomy predictions about the future.1/ The primary purpose of this paper is to present an analysis of PhD enrolment alternatives as they relate to academic staff supply and demand. Since the universities play a very important role in providing employment for PhDs the analysis also sheds light on the magnitude of the alleged unemployment problem for PhDs in Ontario.

The Level of Aggregation of the Analysis

One vital decision that must be made initially relates to the choice of disciplines or discipline groupings into which academic staff are sub-divided for the analysis. In manpower studies it is not normally desirable to produce estimates of the supply of and demand for graduates in each and every field such as Chemical Engineering or Psychology because of the considerable occupational mobility that exists among graduates. For instance, many technically trained individuals find employment in essentially non-technical areas while others work in technical fields other than those in which they were educated. Instead, it is usual to group related or allied fields into half a dozen or so major discipline groupings and undertake the analysis at this level of aggregation. If this were not done it would be necessary to obtain up-to-date detailed information about mobility patterns of individuals in a given field as well as all of its allied fields. Such information usually does not exist. On the other hand, if the discipline groupings chosen are too large, important individual variations between the supply of and demand for graduates in different disciplines may be lost.

Most authoritative manpower studies use fairly high levels of occupational aggregation. For example, the American National Academy of Sciences usually employs six major discipline groupings: Physical Sciences and Engineering, Biological Sciences, Social Sciences, Arts and Humanities, Professional Fields and Education.2/ The individual disciplines or fields that comprise each of these groupings are listed and each field is itself sub-divided into sub-fields.

A finer breakdown of discipline groupings for the purpose of analysing the supply of and demand for academic staff is both possible and desirable because there is less interdisciplinary mobility within the academic world

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1/ Frank Kelly, Prospects for Scientists and Engineers in Canada, Background study for the Science Council of Canada, Special Study No. 20, March 1971.
Science Council of Canada, PhDs piled high and deep: "The Bonneau Report Revisited", unpublished report, 1970.
Marjaleena Repo, I'm a PhD. Who needs the PhD? Graduate Students Union, University of Toronto, Toronto.

2/ National Academy of Sciences, Doctoral Recipients from United States Universities 1958-1966, Washington, D. C., 1967.

than outside of it. For example, most full-time academic staff of a Physics department would have been educated primarily in this field. (We note with approval however the healthy trend toward the creation and expansion of centres of interdisciplinary studies.)

The main constraints in the choice of the discipline groupings for this study are the level of aggregation and degree of compatibility of the available data. The three main sources of data employed here are Report of the Minister of University Affairs of Ontario published by the Ontario Department of University Affairs, Survey of Higher Education, Parts I and II, published by the Dominion Bureau of Statistics, and the Survey of Employment of Ontario PhD Graduates 1964-69 undertaken for the Ontario Council on Graduate Studies. Unfortunately, the classifications of disciplines shown in these sources are only approximately compatible at fairly high levels of aggregation. For instance the DUA report shows undergraduate programmes distributed into six major discipline groupings while DBS lists individual faculties. For the latter this results in more than half of the enrolment being lumped into one of three faculties entitled Arts, Pure Science and Arts, and Pure Science and thus the utility of the enrolment information is reduced.

On the supply side it turns out that the data on the present employment of Ontario PhDs are distributed into six categories as defined by OCGS: Humanities, Social Sciences, Physical Sciences, Biological Sciences, Engineering and Other Disciplines. The analysis in Addendum 1 shows that if we restrict ourselves to the four discipline groupings Humanities, Social Sciences, Biological Sciences and Physical Sciences a fair degree of compatibility between OCGS, DUA and DBS data is possible. These four discipline groupings are therefore employed in this analysis.

Exclusions

In the course of our preliminary investigations it became evident that certain types of students and staff could seriously bias our results if great care were not exercised. More specifically, decisions on inclusion or exclusion of first professional degrees such as Dentistry and Medicine and the newly integrated colleges of Education had to be taken. It is very doubtful that first professional degrees could ever be included on the same basis as PhDs. Our solution to this problem was at least traditional, if not wholly satisfactory, i.e., omit the Health Sciences group from our analysis entirely (see Addendum 1). The rationale for this course of action was that this component of the university is better treated separately in any case. Similarly, we have found it convenient to regard Education as a candidate for a separate analysis because full integration into the university has not yet occurred in this area and all but the most recent of our data excludes educational enrolments. Accordingly, throughout the entire paper, adjustments to the Social Sciences and Biological Sciences discipline groupings will be consistently made on all data on both the demand and supply side of the analysis.

The Demand for Academic Staff with PhDs in Ontario

In the years 1967-68, 1968-69, 1969-70 and 1970-71 the FTE student/full-time staff ratios at Ontario universities were 15.7, 16.9, 16.2 and 16.7 respectively; over the three-year period the average value of this ratio was 16.4. While there is a year-to-year variation of ±4% the average value of this ratio would appear to lie in the range of 16 to 17.

Our approach to estimating the demand for full-time university academic staff in Ontario will assume that total and incremental student/staff ratios will not be permitted to vary greatly during the projection period (1971-72 to 1976-77). We shall produce estimates based on full-time equivalent enrolment ratios because it is known that part-time enrolment is increasing substantially faster than full-time enrolment and therefore part-time enrolments must be taken into account. On the other hand the only staff data available to us relates to full-time staff as defined by each individual university. Thus, the ratios used will of necessity, be total and incremental full-time equivalent student enrolment to full-time staff. Obviously this approach assumes near constancy in the proportions of full-time, part-time and supplementary staff as well as in the undergraduate to graduate enrolment ratios. Graduate and undergraduate enrolments in Ontario have recently been increasing at similar rates. Graduate enrolment restrictions could imply an increase in the ratio. On the other hand, developing policy on integration of part-time and full-time programmes could exert downward pressures on future ratios. In any event it would probably require a major change in enrolment and/or staffing patterns to significantly affect the estimated demand for academic staff. While we cannot entirely rule out the possibility of such major changes, this analysis proceeds on the assumption that such changes, if they do occur will be minor in their effects. Figure 1 shows the actual full-time, FTE of part-time and total FTE student enrolments in Ontario in 1969-70 and 1970-71 as well as two projections of total FTE enrolment through 1976-77. The full-time projection #2A made by the Ontario Institute for Studies in Education 3/ and Zsigmond and Wenaas' total full-time projection produced for the Economic Council of Canada 4/ were modified by the author to reflect exclusions and FTE adjustments.

Both enrolment estimates employed in this paper are likely to be over-estimates if the moderation of enrolment increases beginning to be observed in 1971-72 signals the beginning of a new pattern of enrolment growth. If, however, the 1971-72 expected enrolment drop-off is anomalous or is the result of students "stopping-out" rather than "dropping out" of university the two enrolment projections used are reasonable. In any event they differ by only 6000 students in 1976-77.

3/ Cicely Watson and Saeed Quazi, Ontario University and College Enrolment Projections to 1981-82, OISE, 1968.

4/ Zsigmond and Wenaas, Enrolment in Educational Institutions by Province 1951-52 to 1980-81, Economic Council of Canada, 1968.

Ontario University FTE Enrolments in 1969-70 and 1970-71 and two Projections to 1976-77

	Year	Total full-time based on OISE #2A	Total full-time based on E.C.	FTE of Total part-time modified E.C.	Total FTE Based on OISE #2A & PT mod. E.C.	Total FTE Based on Total E.C.
Past	1969-70		93,956	17,038	110,994	
Past	1970-71		104,970	19,761	124,731	
Projections	1971-72	116,800	113,200	20,400	137,200	133,600
Projections	1972-73	126,600	126,100	22,600	149,200	148,700
Projections	1973-74	137,100	138,000	24,700	161,800	162,700
Projections	1974-75	149,300	153,300	27,400	176,700	180,700
Projections	1975-76	161,200	167,000	29,800	191,000	196,800
Projections	1976-77	173,500	179,600	31,900	205,400	211,500

Sources: CPUO Brief to the Committee on University Affairs December 1970.
Reports of the Minister of University Affairs 1967-1970.
Excluded are all medical interns, Preliminary year students, Diploma and Technology students as well as enrolments in the following faculties: Education, Medicine, Dentistry, Nursing, P.O.T., Optometry and Hygiene and Public Health.
Waterloo Lutheran and Regis College included.
Royal Military College and O.C.A. excluded.
All church-related and theological institutions included.

FIGURE 1

Since several types of students such as medical interns and nursing students (see Addendum 1) were excluded the projections were obtained by applying the year-to-year rates of increase of the two projections to our 1970-71 enrolment sub-set based on DUA data. For example, between 1970-71 and 1971-72 the OISE projection #2A indicated a rise of 11.3% in total full-time enrolment from 117,100 to 130,300 students. After the exclusions detailed in Addendum 1, the DUA total full-time enrolment (actual) in 1970-71 was 104,970 students. Thus, we have applied a 11.3% increase to the 1970-71 base of 104,970 students to obtain an OISE-based projection of 116,800 in 1971-72. It must be emphasized that both projections relate to a sub-set of the total university enrolment in Ontario. For part-time, only an E.C. projection was available and, as it turned out, the actual 1970-71 FTE of part-time had already exceeded the projection (made in 1968) by between 2000 and 3000 students. Accordingly, we have added 2000 students to the original estimates in each year of the projection period to produce a conservative modified FTE of part-time projection. No attempt was made to discount the part-time projections to compensate for our enrolment exclusions because the FTE of these exclusions was small (about 900 students, of which almost 800 were in Education) and the fact that the E.C. estimates had already proved to be low. The two estimates of total FTE enrolment were obtained by adding the modified FTE of part-time enrolment to each of the total full-time enrolment projections.

In Figure 2 we have distributed the 1969-70 DBS total full-time university staff into the four major discipline groupings using the principal subject as defined by DBS as a guide. (The 1970-71 staff data have not been made available to us). We have also eliminated the staff of the following faculties: Education, Medicine, Dentistry, Nursing, Physical and Occupational Therapy, Optometry and Hygiene and Public Health. However, the staff data available to us do not include any part-time staff at all nor do they include full-time staff at the church-related institutions, Waterloo Lutheran or Regis College. For Waterloo Lutheran and Regis College we have compensated by increasing the staff in each discipline grouping related to enrolment increases on the assumption that the student/staff ratios at these institutions are very nearly the same as the overall average student/staff ratio. For the church-related colleges we have assumed that the teaching services performed by the colleges for the universities would be principally in Humanities and Social Science since the colleges do not have facilities for teaching Science. We have assumed that 90% of the service performed for the universities would be in the Humanities and the remaining 10% in Social Science. On this basis the total full-time university staff has been increased to include the church-related colleges' full-time staff, again on the assumption that an equal average student to staff ratio prevails at both the universities and the federated colleges. Finally, a small adjustment has been made for enrolment at the theological colleges such as Knox and Wycliffe. All of this latter adjustment has been made in Humanities.

Figure 2 also shows the percentage distributions of staff in each discipline grouping. An examination of enrolment trends during the sixties reveals that Social Science is increasing its share of total enrolment to a moderate extent and Humanities to a slight extent. This is being accomplished primarily at the expense of Physical Science and to a lesser extent Biological Science. Accordingly, we shall assume a slightly modified distribution in each year of the projection period to take account of these trends.

Total Full-time Staff (1969-70)

	Total full-time University Staff	Compensated for Regis & Waterloo Luth.	Compensated for Church-related Colleges	Compensated for Theological Colleges	Total full-time staff	%
Humanities	1,735	171	129	36	2,071	30.2
Social Sciences	2,236	48	14	-	2,298	33.5
Biological Sciences	544	-	-	-	544	7.9
Physical Sciences	1,940	7	-	-	1,947	28.4
TOTAL	6,455	226	143	36	6,860	100.0

FIGURE 2

Figure 3 shows the two estimates of the total staff required assuming that the average FTE student/full-time staff ratio prevailing during the past four years (16.4:1) will remain constant during the projection period while Figure 4 shows the same two estimates by year and by discipline grouping. The numbers in parentheses represent the percentage shares of enrolment in each discipline grouping. It may be seen that we have assumed small upward and downward changes in these percentages for Humanities and Biological Sciences respectively and moderate upward and downward changes for Social Sciences and Physical Sciences respectively.

Projections of Total Full-time Staff Required
@ 16.4:1 student/staff ratio
1971-72 to 1976-77

	FTE Enrolment		Total Staff Required	
Year	OISE #2A	E.C.	OISE #2A	E.C.
1969-70	110,994	110,994	6,860	6,860
1970-71	124,731	124,731	7,606 (est)	7,606 (est)
1971-72	137,200	133,600	8,366	8,146
1972-73	149,200	148,700	9,098	9,067
1973-74	161,800	162,700	9,866	9,921
1974-75	176,700	180,700	10,774	11,018
1975-76	191,000	196,800	11,646	12,018
1976-77	205,400	211,500	12,524	12,896

Projections

FIGURE 3

Projections of Full-time Staff Required to 1976-77 (Based on OISE #2A)

	Year	Humanities	Social Sciences	Biological Sciences	Physical Sciences	Total
		(30.2)	(33.5)	(7.9)	(28.4)	
	1969-70	2071	2298	542	1948	6,860
		(30.3)	(33.8)	(7.8)	(28.1)	
	1970-71	2305	2571	593	2137	7,606
		(30.4)	(34.1)	(7.7)	(27.8)	
	1971-72	2543	2853	644	2326	8,366
		(30.5)	(34.4)	(7.6)	(27.5)	
	1972-73	2775	3130	691	2502	9,098
		(30.6)	(34.7)	(7.5)	(27.2)	
Projections	1973-74	3019	3424	740	2684	9,866
		(30.7)	(35.0)	(7.4)	(26.9)	
	1974-75	3308	3771	797	2898	10,774
		(30.8)	(35.3)	(7.3)	(26.6)	
	1975-76	3587	4111	850	3098	11,646
		(30.9)	(35.6)	(7.2)	(26.3)	
	1976-77	3870	4459	902	3294	12,524

Projections of Full-time Staff Required to 1976-77 (Based on E.C. Projections)

		(30.2)	(33.5)	(7.9)	(28.4)	
	1969-70	2071	2298	542	1948	6,860
		(30.3)	(33.8)	(7.8)	(28.1)	
	1970-71	2305	2571	593	2137	7,606
		(30.4)	(34.1)	(7.7)	(27.8)	
	1971-72	2477	2778	627	2265	8,146
		(30.5)	(34.4)	(7.6)	(27.5)	
	1972-73	2766	3119	689	2493	9,067
		(30.6)	(34.7)	(7.5)	(27.2)	
Projections	1973-74	3036	3443	744	2698	9,921
		(30.7)	(35.0)	(7.4)	(26.9)	
	1974-75	3383	3856	815	2964	11,018
		(30.8)	(35.3)	(7.3)	(26.6)	
	1975-76	3696	4236	876	3192	12,000
		(30.9)	(35.6)	(7.2)	(26.3)	
	1976-77	3985	4591	929	3392	12,896

FIGURE 4

We have performed a rough analysis of staff attrition due to deaths and retirements using DBS Ontario salary data for 1968-69, the latest complete data set available to us. To bring the information up to date we shifted the age distribution upwards by 2 years i.e., if there were 28 academics 63 years old in 1968-69 we assumed that there would be 28 staff members 65 years old in 1970-71. This is an approximation because some will have died or retired prematurely while it is possible (although unlikely at 63) that some new staff will have been hired. We then assumed that all staff will retire promptly at 65 during the projection period. This leads to a first estimate of an average .56% retirement rate over the projection period. This estimate probably represents a floor because of the exclusion of premature retirements. On the other hand it is true that some staff members stay on beyond age 65 and this would tend to compensate for the former exclusion. Overall we feel that a .7% retirement rate is a reasonable working estimate. For attrition due to deaths, we have applied male mortality rates to the staff distribution and obtained an estimate of about .6% deaths in each year of the projection period. Taken together these yield a total attrition rate due to deaths and retirements of 1.3%. However, to be on the safe side we shall use 1.5% in our calculations. (The difference due to using 1.5% instead of 1.3% is just 14 staff members/year.) The reason for the relatively low attrition rate due to deaths and retirements lies in the nature of the staff distribution, most of the staff being concentrated in the lower age brackets.

In addition, some staff will leave the university system for other reasons. Our only estimate of this percentage is based upon an overall figure of 3.4% for deaths, retirements and other losses which ultimately appeared to become accepted during the much publicized Mathews-Safarian debate. Accordingly, we shall assume an overall 3.5% per year attrition rate i.e., 2% of all academic staff are assumed to leave the system each year. The attrition rate is applied to the estimated full-time staff required in each year giving the results shown in Figure 5.

Annual Replacements for Deaths & Retirements @ 3.5% Attrition Rate*

Year	Humanities	Social Sciences	Biological Sciences	Physical Sciences	Total
1971-72	89	100	23	81	293
1972-73	97	110	24	88	318
1973-74	106	120	26	94	345
1974-75	116	132	28	101	377
1975-76	126	144	30	108	408
1976-77	136	156	32	115	438

*Figures may not sum to Total due to rounding errors.

FIGURE 5

Figure 6 gives the two estimates of the total additional full-time staff required (including replacements for deaths and retirements) by year and by discipline grouping.

Of the new staff required, only a proportion will possess the PhD degree. To obtain information on these historical proportions for each discipline grouping, we have made use of some of the preliminary findings of the Manpower Information and Analysis branch contained in a paper entitled "The Manpower situation among new PhD graduates". This study, based on 1969, 1970 and 1971 data indicates that of 2,617 staff hired by universities in Canada some 1,537 (59%) had completed their PhD degree. This is also evidence that the percentage of total staff holding PhDs has been steadily increasing during the sixties 5/ despite the assertions of Walter Hettich in his Special Study No. 14 prepared for the Economic Council of Canada.6/ It seems likely that with the present availability of PhD holders this percentage will continue to rise. The corresponding percentage figures for our four discipline groupings are Humanities (39%), Social Sciences (45%), Biological Sciences (85%) and Physical Sciences (89%) and therefore we shall arbitrarily increase these percentages to 60%, 65%, 90% and 95% respectively and assume that they are operative during the projection period. Figure 7 shows our two estimates of the demand for PhDs required by Ontario universities in each year of the projection period assuming a constant student/staff ratio.

Some researchers have suggested that incremental student/staff ratios should be employed for this type of demand analysis because such ratios are quite often significantly different from the overall student/staff ratios and the analysis of demand is quite sensitive to variations in any ratios employed. Accordingly we shall examine some incremental ratios in the immediate past and produce this alternative.

Incremental FTE student/full-time staff ratios for 1967-68 to 1968-69, 1968-69 to 1969-70, and 1969-70 to 1970-71 are shown in Figure 8. For the first of these years the ratio is 28.3, for the second 12.3, and for the third 22.2. It would be unrealistic to expect staff and student increases

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5/ Dominion Bureau of Statistics, Salaries and Qualifications of Teachers in Universities and Colleges, 1963-64 through 1968-69.

6/ Walter Hettich, Special Study No. 14, Expenditures, Output and Productivity in Canadian Universities. Hettich offers some statistics (Table 5-4 on page 57) which he manages to interpret as evidence that the proportion of PhDs among university faculty has not improved overall. He achieves this by pointing out that for two of the eight discipline groupings employed the proportions have declined slightly while for the other six they have risen. On this basis he concludes that the evidence is "mixed". In fact, when all of his categories are merged the overall proportion increases from about 43% in 1963-64 to almost 50% in 1968-69. We regard his interpretation as completely unfounded.

Estimate of Additional full-time Staff Required to 1976-77 Including Replacements for Deaths and Retirements (Based on OISE #2A)

Year	Humanities	Social Sciences	Biological Sciences	Physical Sciences	Total
1971-72	328	382	74	270	1053
1972-73	329	386	71	264	1050
1973-74	350	414	74	276	1114
1974-75	405	480	85	316	1286
1975-76	405	484	83	308	1280
1976-77	418	504	83	311	1316

Estimate of Additional Full-time Staff required to 1976-77 Including Replacements for Deaths and Retirements (Based on E.C. estimates)

1971-72	259	305	56	207	826
1972-73	386	450	86	316	1238
1973-74	377	444	81	299	1201
1974-75	465	549	100	369	1483
1975-76	443	528	91	340	1402
1976-77	428	516	85	318	1348

FIGURE 6

Estimate of PhDs Required by Ontario Universities
(Based on OISE #2A)
(1971-72 to 1976-77)

Year	Humanities	Social Sciences	Biological Sciences	Physical Sciences	Total
	(60%)	(65%)	(90%)	(95%)	
1971-72	197	248	66	256	768
1972-73	197	251	64	251	763
1973-74	210	269	67	262	808
1974-75	243	312	77	300	932
1975-76	243	315	74	293	925
1976-77	251	327	75	296	949

Estimate of PhDs Required by Ontario Universities
(Based on E.C. Projection)
(1971-72 to 1976-77)

1971-72	155	198	50	196	600
1972-73	232	293	77	300	902
1973-74	226	289	73	285	872
1974-75	279	357	90	351	1077
1975-76	266	343	82	323	1014
1976-77	257	335	77	302	971

FIGURE 7

Ontario University Incremental FTE Enrolments
and Incremental full-time Staff
(1967-68 to 1968-69, 1968-69 to 1969-70 and 1969-70 to 1970-71)

Year	Full-time	FTE of part-time	Total FTE	Incremental full-time staff*	Incremental student to staff ratio
1967-68 to 1968-69	12,890	3,208	16,098	569	28.3
1968-69 to 1969-70	10,824	1,545	12,369	1,006	12.3
1969-70 to 1970-71	11,014	2,723	13,737	619	22.2
3-year average	34,728	7,476	42,204	2,194	19.2

*Corrected for church-related colleges and additional institutions such as Waterloo Lutheran by adding 6.3% to the total university full-time staff.

FIGURE 8

to be perfectly matched chronologically, and therefore we have taken a three-year average which works out to 19.2:1. Shortages of funds could mean that a ratio of 20.0 will prevail during the projection period compared with an average of 19.2:1 from 1967-68 to 1969-70. 7/ The additional staff required (Figure 9) are then distributed into the major discipline groupings in such a way that the percentage distributions in each year as given in Figure 4 are maintained. This does not mean that the additional staff are distributed according to the percentages in Figure 4 Instead, the total staff in any year are so distributed. For example, in 1971-72 and 1972-73 30.4% and 30.5% of the total full-time academic staff are expected to be in the Humanities sector while the total number of staff in 1970-71 was 7,606 of whom 2,305 were in Humanities (Figure 4). Also the OISE based estimate suggests that 623 and 600 additional staff will be required in 1971-72 and 1972-73. Thus, if X is the additional Humanities staff required in 1971-72 then $2,305 + X = .304\ (7,606 + 623)$ i.e., the total Humanities component in 1971-72 must represent 30.4% of the total staff. If we solve the above equation we find that X = 197 which is different from 30.3% of the additional staff. Similarly, in 1972-73 we have $(2,305 + 197 + X) = .305\ (7,606 + 623 + 600)$ and so on. Figure 10 shows the total additional staff by discipline grouping including the replacements for attrition obtained from Figure 5. Finally, we have applied the proportion of PhDs required by the Ontario universities in each year of the projection period (Figure 11). However, some portion of the academic staff positions in Ontario will not be available to Ontario PhDs for various reasons having to do with qualifications and therefore an estimate of the magnitude of the foreign component of the staff that will be added during each year of the projection period is required. We have some data for eight of the fourteen universities which show that between 1969-70 and 1970-71 the Canadian component of all academic staff in Humanities remained at 49%. The corresponding figures for the other discipline groupings are shown in Figure 12. It will be assumed that the eight universities in the sample are typical of the system and in the rightmost column of Figure 12 we have chosen four percentages as estimates of the size of the Canadian component of new staff for each discipline grouping. These percentages are based not only on the relative sizes of the total and additional staff in each discipline grouping but on the reasonable expectation that every effort would be made to employ Canadians during the projection period. Thus, our estimates of the percentages in each discipline grouping were all increased by some percentage points, e.g., Humanities was raised from 49% to 60%.

In Figure 13 these percentages have been applied to the OISE #2A and E.C. estimates to give the demand for Ontario PhDs in each discipline grouping during the projection period.

7/ This compares with an incremental student/staff ratio of 20.0:1 used by Max von Zur-Muehlen in his paper entitled The PhD Dilemma in Canada.

Additional Staff Required @ 20.0:1
Student/Staff Ratio
(1971-72 to 1976-77)

Year	Enrolment increments		Additional staff required	
	OISE #2A	E.C.	OISE #2A	E.C.
1971-72	12,470	8,870	623	443
1972-73	12,000	15,100	600	755
1973-74	12,600	14,000	630	700
1974-75	14,900	18,000	745	900
1975-76	14,300	16,100	715	805
1976-77	14,400	14,700	720	735

FIGURE 9

Estimate of Additional full-time Staff to 1976-77
Including Replacements for Attrition (Based on OISE #2A)

Year	Humanities	Social Sciences	Biological Sciences	Physical Sciences	Total
1971-72	278	325	61	226	890
1972-73	280	331	60	222	893
1973-74	299	355	63	233	948
1974-75	344	409	72	266	1090
1975-76	346	415	70	261	1092
1976-77	359	433	71	265	1128

Estimate of Additional full-time Staff to 1976-77
Including Replacements for Attrition (Based on E.C. Estimates)

1971-72	223	264	47	175	710
1972-73	325	381	71	263	1040
1973-74	320	378	68	251	1017
1974-75	392	464	83	308	1247
1975-76	377	450	77	287	1191
1976-77	368	443	72	272	1155

FIGURE 10

Estimate of PhDs Required by the Ontario Universities to 1976-77
Based on OISE #2A (incremental)

Year	Humanities	Social Sciences	Biological Sciences	Physical Sciences	Total
Proportion of PhDs	(60%)	(65%)	(90%)	(95%)	
1971-72	167	211	55	214	647
1972-73	168	215	54	211	648
1973-74	179	230	56	221	687
1974-75	206	266	65	253	789
1975-76	208	270	63	248	788
1976-77	215	281	64	252	812

Estimate of PhDs Required by the Ontario Universities to 1976-77
Based on E.C. estimate (incremental)

1971-72	134	172	43	167	515
1972-73	195	248	64	250	757
1973-74	192	246	61	239	738
1974-75	235	302	75	293	904
1975-76	226	293	69	273	860
1976-77	221	288	65	258	832

FIGURE 11

Percentages of full-time Academic Staff by
Citizenship and Discipline Group*
1969-70 and 1970-71

	Canadian		Non-Canadian		Estimated
Discipline Group	1969-70	1970-71	1969-70	1970-71	Canadian Percentage
Humanities	49%	49%	51%	51%	60%
Social Sciences	56%	59%	44%	41%	70%
Biological Sciences	76%	75%	24%	25%	80%
Physical Sciences	63%	60%	37%	40%	70%

*Source: Citizenship of full-time academic staff at Ontario Universities 1969-70 and 1970-71
Based on eight universities only: Brock, Guelph, Laurentian, Ottawa, Trent, Waterloo, Western, York.

FIGURE 12

The Demand for Academic Staff with PhDs Available for Canadians to 1976-77
Based on OISE #2A (incremental)

Year	Humanities	Social Sciences	Biological Sciences	Physical Sciences	Total
Proportion of Canadians	@60%	@70%	@80%	@70%	
1971-72	100	148	44	150	442
1972-73	101	151	43	148	442
1973-74	108	161	45	155	469
1974-75	124	186	52	177	538
1975-76	125	189	50	174	537
1976-77	129	197	51	176	553

The Demand for Academic Staff with PhDs Available for Canadians to 1976-77
Based on E.C. estimate (incremental)

1971-72	80	120	34	117	351
1972-73	117	173	51	175	517
1973-74	115	172	49	167	503
1974-75	141	211	60	205	617
1975-76	136	205	55	191	587
1976-77	132	202	52	181	567

FIGURE 13

The Supply of PhDs

We begin by collecting and deriving estimates of the numbers of PhDs that will be produced in Ontario in each year of the projection period. Several estimates will be employed, the first of these being based on projections made for the Economic Council of Canada by Z. E. Zsigmond and C. J. Wenaas.8/ In 1969-70, the last year for which DBS data are available, 640 doctorates were granted in Ontario. This compares favourably with the E.C. estimate of 650. In 1970-71 the universities reported 646 doctorates as compared with an Economic Council projection of 681 (after Education and Health Science exclusions). The doctorates granted in 1969-70 and 1970-71 were distributed among the four major discipline groupings as shown in Figure 14.9/ Examination of historical enrolments patterns in the sixties reveal that Social Science is increasing its share of total enrolment to a moderate extent and Humanities is increasing its share to a slight extent. This is being accomplished at the expense primarily of Physical Science and to a lesser extent of Biological Science. Accordingly we shall apply a somewhat modified distribution of the last available year to Zsigmond and Wenaas' estimates. (Figure 14) Under this projection doctoral production will rise to a total of 1,492 by 1976-77 if exclusions of 148 doctorates for the disciplines listed in Addendum 1 are made. This estimate is given only to provide a ceiling estimate for analytical purposes.

Another estimate of the number of students graduating with PhDs from Ontario universities in each year of the projection period may be obtained from an examination of past and projected enrolments and past doctoral degrees granted. As is so often true we have only limited data to work with, in this case 3 years actual and 2 years estimated data. Until recently neither DBS nor DUA bothered to separate doctoral and master's enrolments. More importantly, no effort was made to measure the intake of graduate students. Therefore, we shall have to employ a somewhat complicated method of arriving at an estimate of future PhD production.

To begin with we note that doctoral enrolments, graduations and intakes in successive years are related by the following formula:

$$E_x = E_{x-1} - G_{x-1} + I_x - D_{x-1} \qquad (1)$$

where E_x, G_x, I_x and D_x represent the enrolment, the number of graduations, the intake of new students and the number of dropouts in year x, and x-1 represents the previous year.

8/ Z. E. Zsigmond and C. J. Wenaas, Staff Study No. 25: Enrolment in Educational Institutions by Province 1951-52 to 1980-81.

9/ Doctorates granted in Medicine (26), Public Health (3), and Education (30) were excluded before computing the distribution. Doctorates in all of the other disciplines to be excluded listed in Addendum 1 were zero.

Estimate of Ontario doctoral production by discipline grouping based on E.C. projection and present shares of enrolment*

	% Distribution as of 1969-70**	% Distribution as of 1970-71***	Actual 1969-70	Actual 1970-71	Modified % distribution	Predicted Distribution 71-72	72-73	73-74	74-75	75-76	76-77
Humanities	15.3	16.6	) 98	118	16.0	139	157	181	202	232	262
Social Sciences	13.4	14.6	) 86	104	19.0	165	186	215	239	276	312
Biological Science	11.7	15.4	75	109	15.0	131	147	170	189	218	246
Physical Science	50.3	44.4	322	315	41.0	357	402	463	517	595	672
Exclusions	9.2	9.0	59	64	9.0	78	88	101	113	129	148
TOTAL	100.0	100.0	640	710	100.0	870	980	1130	1260	1450	1640
Total less exclusions			581	646		792	892	1029	1147	1321	1492

* Columns may not sum to TOTAL due to rounding errors.
** Based on DBS data Catalogue 81-211, 1969-70.
*** Based on the Ontario university briefs to CUA for 1970-71.

FIGURE 14

We have enrolment data from different sources as shown in Figure 15. The data for 1968-69 and 1969-70 were obtained from the 1970 statistical report of the Canadian Association of Graduate Schools and two of the discipline groupings have been adjusted so that Health Sciences and Education have been excluded. The actual data for 1970-71 and estimates for 1971-72 were obtained from the briefs of the universities to CUA and have been adjusted on the same basis as that for the preceding two years. In addition, the part-time enrolment component has been estimated on the assumption that the ratio between part-time and full-time enrolments for each discipline grouping will remain constant at 1969-70 levels. The statistics from the two sources are comparable; doctoral students, as a percentage of all graduate students (based on DUA data) for 1969-70 and 1970-71 represent exactly 41.8% in both cases even though the sources of data on doctoral enrolments differ. For 1968-69 the corresponding figure is 40.8% and by extrapolation we estimate the doctoral enrolment in 1967-68 to have been 40% of total graduate enrolment. Overall we feel that only the 1971-72 figure is liable to be inaccurate and if so, it is probably an underestimate.

Total (full and part-time) Doctoral Enrolment
by Discipline Grouping

All figures exclude Health Sciences and Education

Year	Source	Humanities	Social Science	Physical Science	Biological Science	Total
1967-68	COU based on DUA data	956	663	1446	387	3452
1968-69	Canadian Assn. of Grad. Schools	1127	782	1703	456	4068
1969-70		1444	1045	2004	514	5007
1970-71	CAGS	1625	1260	2127	598	5610
1971-72 (est)	Universities	1798	1621	1921	500	5840

FIGURE 15

We also have some information on past and projected graduations (Figure 16). For the purposes of this analysis only past graduations are required but university estimates of future graduation are given because we shall be using them for comparative purposes. Equation 1 may be re-written as

$$I_x = E_x - E_{x-1} + G_{x-1} + D_{x-1} \quad (2)$$

If we substitute values from Figures 3.15 and 3.16 for I_{68-69}, I_{69-70}, $I_{70\ 71}$, and I_{71-72} we obtain

$$I_{68} = 4068 - 3452 + 437 + D_{67} \quad (3)$$

$$I_{69} = 5007 - 4068 + 460 + D_{68} \quad (4)$$

$$I_{70} = 5612 - 5007 + 581 + D_{69} \quad (5)$$

$$I_{71} = 5840 - 5612 + 646 + D_{70} \quad (6)$$

where the D's represent dropouts during the year indicated by the subscript. We shall use the following model in order to estimate the dropouts. All doctoral students are assumed to either graduate or dropout within five years according to the following pattern: 10/

Success	0.0	0.0	0.30	0.40	0.10
Failure	0.0	0.05	0.05	0.05	0.05

Thus, 30%, 40% and 10% of doctoral students are assumed to graduate in the third, fourth and fifth years respectively while 5% dropout in each of the five years except the first.

Using this model we may write:

$$I_{68} = 1053 + .05\ [I_{64} + I_{65} + I_{66} + I_{67}] \quad (7)$$

$$I_{69} = 1399 + .05\ [I_{65} + I_{66} + I_{67} + I_{68}] \quad (8)$$

$$I_{70} = 1186 + .05\ [I_{66} + I_{67} + I_{68} + I_{69}] \quad (9)$$

$$I_{71} = 874 + .05\ [I_{67} + I_{68} + I_{69} + I_{70}] \quad (10)$$

Therefore we know that:

$$I_{68} > 1053 \quad (11)$$

$$I_{69} > 1399 \quad (12)$$

$$I_{70} > 1186 \quad (13)$$

where the I's are a first approximation.

10/ These values approximate those suggested in M. A. Preston, Employment of Students Awarded PhDs 1970-71 and Some Comments, July 27, 1971.

Actual and Projected Doctoral Degrees Granted
All figures exclude Health Sciences and Education

Year (Actual)	Source	Humanities	Social Sciences	Physical Sciences	Biological Sciences	Total
1966-67	DBS based on Zsigmond	51	45	165	39	300
1967-68	DBS based on Zsigmond	74	66	240	57	437
1968-69	DBS	78	70	252	60	460
1969-70	DBS	98	86	322	75	581
1970-71	Universities	118	104	315	109	646
(Projected)						
1971-72		156	171	345	133	805
1972-73		177	207	367	136	887
1973-74	Universities as reported in their briefs to CUA	203	230	370	143	946
1974-75		222	255	369	155	1001
1975-76		230	275	373	164	1042
1976-77		239	293	354	189	1075

FIGURE 16

If we substitute from the foregoing inequalities in equation (10) we obtain

$$I_{71} = 874 + .05 \left[I_{67} + 3638 + \sum_{i=67}^{70} \phi\, i\right] \qquad (14)$$

or

$$I_{71}' = 874 + .05 \left[I_{67} + 3638\right]$$

where I_{71}' is to be regarded as a second approximation and $\sum \phi_i$ a correction term. We know that the graduate intakes were rising during the late 60's and we may, by inspection, estimate I_{67} to have been about 900. In any case, it is obvious that even if it were 800 or 1,000, the value of I_{71}' would not shift appreciably. Upon this basis we obtain

$$I_{71}' = 874 + 227 = 1101 \qquad (15)$$

If I_{67} had been 800, $I_{71}' > 1096$ and if it had been 1000, $I_{71}' > 1106$. The results are relatively insensitive to large errors in the correction term. Thus, we have found that a first approximation to the correction term for 1971 is 227. If we use this as the correction term for the years 1967 to 1970 we may write

$$I_{71}' = 1101 + .05 \left[908 + \sum_{i=67}^{70} \phi_i\right]$$

or

$$I_{71}'' = 1101 + .05 \left[908\right]$$

where I_{71}'' is a third approximation and $\sum \phi_i$ another and different correction term. Thus,

$$I_{71}'' = 1101 + 45 = 1146 \qquad (16)$$

This will be a slight overestimate because the correction terms for the early years are likely to be a little less than 227. However, we may indicate how accurate the approximation is by noting that a fourth approximation yields a correction of the order of only 9 doctoral students.

Thus, our best estimate of I_{71} is 1146 students. In a like manner we may estimate:

$$I_{70} = 1186 + 203 + 41 = 1430$$

$$I_{69} = 1399 + 163 + 33 = 1595$$

$$I_{68} = 1053 + 135 + 27 = 1215$$

For these calculations we have assumed $I_{64} = 500$ and $I_{65} = 600$, $I_{66} = 700$.

Having obtained estimates for the doctoral intakes we may substitute these values in our model which can be written:

$$G_x = \alpha I_{x-3} + \beta I_{x-4} + \gamma I_{x-5} \qquad (17)$$

where G_x represents the number of graduates in year x and

$\alpha = 0.3$, $\beta = 0.4$, $\gamma = 0.1$

Therefore

$$G_{73} = 0.3\ (1430) + 0.4\ (1595) + 0.1\ (1215) = 1189$$

$$G_{74} = 0.3\ (1146) + 0.4\ (1430) + 0.1\ (1595) = 1075$$

$$G_{75} = 0.3\ (I_{72}) + 0.4\ (1146) + 0.1\ (1430) = 901$$

where we have assumed $I_{72} = 1000$, i.e., significantly less than I_{71}.

We may also estimate G_{76} if it may be assumed that $I_{73} = 1000$ i.e., that doctoral intake will not continue to drop indefinitely and will level off at about 1000 students in 1973-74. Under these assumptions

$$G_{76} = 0.3\ (1000) + 0.4\ (1000) + 0.1\ (1146) = 815$$

Some readers may feel that the results are unduly dependent on the assumed failure rate and pattern of graduations. We shall show that this is not so by using a different failure rate and graduation pattern as shown below and demonstrating that within reasonable limits the results are insensitive to such changes.

Success	0.0	0.06	0.20	0.30	0.20
Failure	0.0	0.06	0.06	0.06	0.06

Here we assume a 24% instead of 20% dropout rate and a different pattern of graduations spread over four years. Repeating the foregoing analysis under the new assumption we obtain

$$I_{71} = 874 + 272 + 65 = 1211$$
$$I_{70} = 1186 + 243 + 58 = 1487$$
$$I_{69} = 1399 + 195 + 47 = 1641$$
$$I_{68} = 1053 + 162 + 39 = 1254$$

Substituting for the I's in

$$G_x = \alpha I_{x-2} + \beta I_{x-3} + \gamma I_{x-4} + \delta I_{x-5} \qquad (18)$$

with $\alpha = 0.06$, $\beta = 0.20$, $\gamma = 0.30$, $\delta = 0.20$

we obtain

$$G_{73} = .06\ (1211) + 0.20\ (1487) + 0.30\ (1641) + 0.20\ (1254) = 1113$$

$$G_{74} = .06\ (1000) + 0.20\ (1211) + 0.30\ (1487) + 0.20\ (1641) = 1077$$

$$G_{75} = .06\ (1000) + 0.20\ (1000) + 0.30\ (1211) + 0.20\ (1487) = 921$$

where we have assumed $I_{73} = 1000$.

It may be seen that there is very little change in the total graduations due to changes in the assumed pattern of graduations (the total graduations for the three years differ by less than 2% for the two alternative cases.) The changes show up mainly in a modified pattern of graduations. This is so because a large part of the students that will graduate in 1971-72 to 1976-77 are already in the system. In the methodology outlined above we have, for illustration purposes, obtained estimates for the total PhDs expected to graduate during the projection period. The same analysis can be and has been performed by discipline grouping and the results are shown in Figure 17. The very slight differences between our calculations and the computer results (which are calculated by discipline) are due to rounding errors.

Yet another estimate of PhD production is shown at the bottom of Figure 16. This one is based on the information contained in the university briefs to CUA. It may be seen that the university projections are reasonably close to our own differing by less than 5% for the total of the three years 1973-74, 1974-75 and 1975-76.

Up to this point, we have estimated the supply of PhDs from Ontario universities during the projection period. However, the problem of arriving at an estimate of academic staff is rather more involved. Just to define what is meant by academic staff is very difficult indeed. Suppose for a moment we replace the definition of the term "academic staff" by a description of the process by which the majority of such staff usually originates. Figure 18 shows the normal development from the Baccalaureate stage to the PhD stage. At this point, the PhD graduate might either (a) find other employment, (b) become an academic staff member or (c) obtain one or more post-doctoral fellowships (solid lines). However, a significant amount of informal and/or temporary instructional resources are provided by graduates between the baccalaureate and the PhD stage e.g., graduates with master's degrees and doctoral candidates with all but dissertation, (ABD's) by post-doctoral fellows and by individuals outside of the formal academic process (broken lines). In addition, there is usually a formal and/or permanent academic input from outside of the university system.

Projected PhD Graduates in Ontario (1971-72 to 1976-77)
Education and Health Sciences Excluded

Year	Humanities	Social Sciences	Biological Sciences	Physical Sciences	Total
1971-72	155	108	110	423	796
1972-73	253	197	118	488	1056
1973-74	330	316	88	454	1188
1974-75	284	334	94	364	1076
1975-76	183	208	130	382	903
1976-77	141	108	125	441	815

FIGURE 17

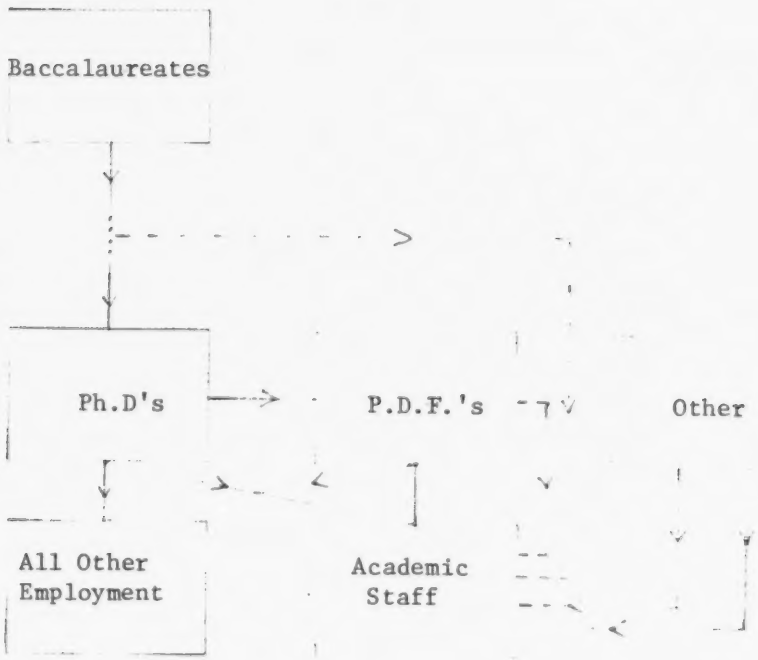

FIGURE 18

Yet another complication lies in the fact that permanently appointed staff may be on a full-time or part-time basis. Each university has its own definition of full-time and part-time staff and these are usually reported to central agencies and merged. Data limitations force us to employ full-time staff as defined by the universities and reported to a central agency, in this case DBS.

In point of fact, what we have just done is accept an uncertain distinction between full-time and part-time staff and in addition make one of our own, albeit a hazy one, between formally and permanently appointed staff usually with PhDs and temporary staff without a formal appointment, usually in the middle or nearing the end of their student careers. These are distinctions, and to a certain extent simplifications, that are forced upon us both by the nature of the process and by the data that are available. As we shall see, the very modest amounts of data on academic staff available to us are restricted to permanent full-time academic staff. In practice, however, there is a certain degree of interchangeability among the three types of academic staff and this introduces an unavoidable source of error into the analysis.

Thus, we tacitly restrict ourselves to estimating the supply of permanent academic staff with PhDs completely ignoring the possibility of substitution of part-time or temporary staff. Over the last decade or so a trend towards the upgrading of academic staff has existed. We shall assume a continuation of this trend but it should be noted that the capacity for economizing by labour substitution exists in the system and it may be brought into play by severe financial cutbacks.

An even more complicated problem stems from the nature of the Ontario university system itself. Both academic staff members and PhDs originate in and flow between Ontario and the rest of the world. Since this analysis is restricted to the Province of Ontario, we shall delineate all of the possible sources and destinations of academic staff outside of the Province and the university system. Figure 19 divides the universe into four sub-sections or sectors necessary and sufficient for this analysis: the Ontario university sector, the rest of Ontario sector, the rest of Canada sector (i.e., all Canada except Ontario) and the rest of the world. Any analysis involving the supply of academic staff will have to take into account the three possible two-way flows of academic staff and PhDs between the Ontario university sector and each of the other three sectors.

Much of the information needed to show the flows of manpower between the relevant sectors does not exist. For instance, as far as we know, no information exists about the flows of either academic staff or PhDs into the university sector from the rest of Canada. When some information does exist, for instance rough estimates of the proportion of newly hired foreign staff, the utility of the information is invariably limited because virtually all of our information is based on ad hoc cross-sectional surveys performed at particular points in time. Thus, the passage of two years may result in very large changes in the measured parameters and it becomes hazardous to assume that a parameter last measured in 1968-69 still obtains in 1970-71 much less through 1976-77.

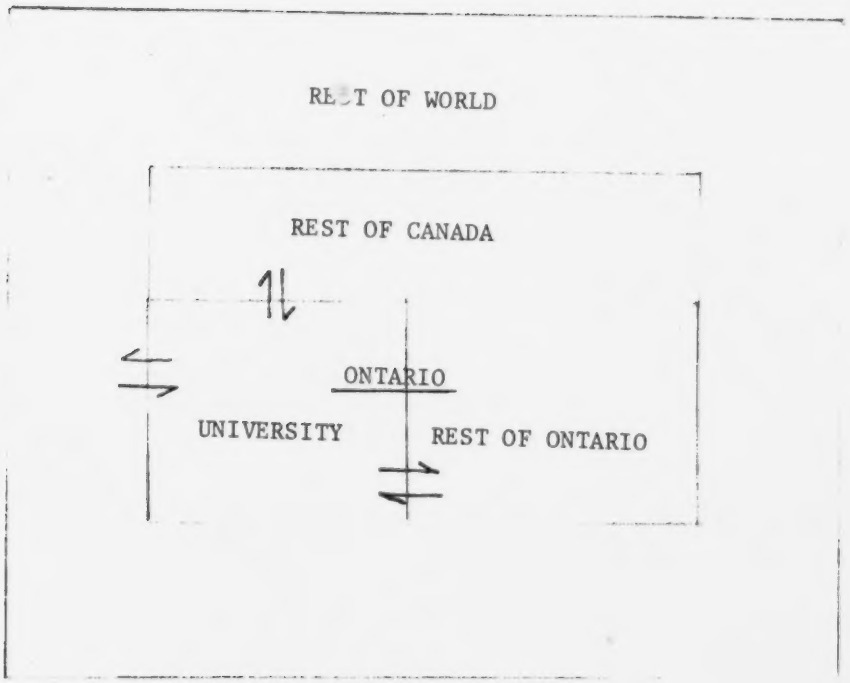

FIGURE 19

Nevertheless, we have to proceed and we shall do so by making what we hope are reasonable assumptions whenever there is missing information. Our approach will be to identify all of the sources of Canadian academic staff with PhDs entering Ontario universities primarily on the basis of historical information. We have already taken into account on the demand side academic PhD staff who leave the Ontario university system. (estimated at 2% per year of total staff). On the supply side there are four possible sources of academic staff with PhDs for the Ontario system, i.e., the Ontario universities, the rest of Ontario, the rest of Canada and the rest of the world. The major source is the Ontario universities and historically (1964-1969) they have supplied to the Ontario system about 57%, 38%, 24% and 23% of their PhD output in Humanities, Social Sciences, Biological Sciences and Physical Sciences respectively (Figure 20). The least significant source of academic staff with PhDs for the Ontario universities is the Rest-of-Ontario sector. We shall assume that the flow of PhDs from the Rest-of-Ontario into the universities is negligible. This is probably a good assumption for Humanities and Social Sciences but it has the effect of somewhat understating the supply of academic staff in the Biological and in the Physical Sciences. A third source of PhD staff for Ontario universities originates in the rest of Canada. Unfortunately, there are no

Employment of Ontario PhDs 1964-69

Percentages

Sector		Humanities		Social Sciences*		Biological Sciences		Physical Sciences**		Total	
		No.	%	No.	%	No.	%	No.	%	No.	%
Ontario Universities	(1)	94	57	86	38	61	24	179	23	420	29
Rest of Ontario	(2)	5	3	31	14	56	22	164	21	256	18
Rest of Canada	(3)	23	14	52	23	39	15	140	18	254	18
Rest of World	(4)	42	26	59	26	98	39	312	39	511	35
		164	100	228	100	254	100	795	100	1441	100

* Also includes Other Disciplines
** Also includes Engineering

FIGURE 20

data that we know of in this area and we shall proceed by noting that Ontario has been, and probably will continue to be, a small net supplier of PhDs to the rest of Canada. Accordingly, on the basis that historically Ontario has supplied some 14%, 23%, 15% and 18% of its PhD output in Humanities, Social Sciences, Biological Sciences and Physical Sciences respectively to the rest of Canada, we shall assume inflows equal to 10%, 20%, 10% and 15% of the Ontario PhD production from the rest of Canada to Ontario during the projection period (Line 3 of Figure 21). It should be noted that if we had assumed no net PhD flows between Ontario and the rest of Canada, the percentages in the total of Figure 21 would be 71%, 61%, 39% and 41% instead of 67%, 58%, 34% and 38%. However, we feel that Ontario will continue to be a small net supplier of PhDs to the rest of Canada and have modified the percentages accordingly. The last source of academic staff with PhDs for the Ontario system is the rest of world sector. This may be divided into two components. Firstly, there are students with PhDs returning soon after graduation and secondly a largely foreign component of usually senior academics.

Assumed annual percentages of PhD production available for university employment

Percentages

Source	Humanities	Social Sciences	Biological Sciences	Physical Sciences
(1) Ontario universities	57	38	24	23
(2) Rest of Ontario	0	0	0	0
(3) Rest of Canada	10	20	10	15
(4) Total	67	58	34	38

FIGURE 21

We derive and match the demand for academic staff with PhDs holding Canadian citizenship with the supply of such staff available to the Ontario universities. We assume that the component of incoming staff from the rest of the world forms most of the non-Canadian component of academic staff with PhDs hired by the Ontario universities. This assumption has the effect of overstating the supply of academic staff from the Ontario universities and the rest of Canada and tends to compensate for the preceding assumption i.e., that PhD flows from the rest of Ontario to the university system are negligible. This leaves the returning Canadian students. These have been estimated for Canada by Dr. Max von zur-Muehlen of the Economic Council of Canada. We shall use his estimates and assume that the Ontario share is proportional to its share of Canadian-produced PhDs by discipline, that 60% of such students return soon after graduation, and that the relative shares of the total absorbed by the Ontario universities and the rest of Ontario are equal to the relative shares of Ontario-produced graduates absorbed by the same two sectors. Under these assumptions, the numbers of returning Canadian PhDs that will be hired by the Ontario universities in each year of the projection period are shown in Figure 22.

By applying these percentages by discipline grouping to the three supply estimates of graduate production and adding in the returning Canadian PhD component, we obtain estimates by year and by discipline grouping of the supply of academic staff with PhDs available to the Ontario university system (1971-72 to 1976-77) Figure 23.

The methodology we have adopted is possibly weak in this area because we attempt to deal only with the requirements of the Province of Ontario. The methodology for estimating the demand for academic staff with PhDs is quite sound and the assumptions reasonable. On the supply side, however, it is possible that the pattern of inter-provincial flows of PhDs could change quite markedly from the recent historical pattern if the relation between supply and demand begins to vary significantly between Ontario and the rest of Canada. Thus, a large unemployed surplus of PhDs seeking academic employment in Ontario would probably migrate to other parts of Canada if there were an equally large deficiency of such manpower in other parts of Canada. Under these dynamic conditions it would be very difficult to estimate how the pattern of inter-provincial flows would change and since our estimates relating to this pattern are critical to the results on the supply side there would be large errors in the estimate of the supply of PhDs seeking academic employment in Ontario. If such were the case a supply/demand analysis would be best carried out at a national level and it would yield quite different results from a similar analysis carried out at the provincial level.

However, if the relation between supply and demand of PhDs seeking academic employment does not vary significantly between Ontario and the rest of Canada, we would expect little or no change in the net pattern of inter-provincial academic mobility and supply/demand analyses carried out at the national and provincial levels would yield quite similar results. Thus, an unavoidable assumption of this analysis is that the assumed pattern of inter-provincial and international flows of academic manpower will not shift appreciably during the projection period.

The Matching of Demand and Supply

We are now in a position to match the demand and supply of academic staff with PhDs for the Ontario university system. In both of the following cases the supply for a given year is matched with the demand for the subsequent year. First, we show the OISE-based incremental demand projection combined with the COU supply projection, (Figure 24) in which the total surpluses in each discipline group over the six year projection period are expressed as percentages of the corresponding demand totals. The results of this scenario suggest that over the projection period there will be a significant oversupply of academic staff with PhDs in Humanities (67% of demand), in Biological and Physical Sciences there will be a small

Anticipated number of foreign doctoral degrees granted to Canadians by country

(1971-72)

Country of Origin	Humanities	Social Sciences	Biological Sciences	Physical Sciences	Total
United States	77	174	101	156	508
Great Britain	40	40	17	51	148
Other Countries	30	23	9	28	90
TOTAL	147	237	127	235	746

Anticipated number of foreign doctoral degrees granted to Ontario students (1971-72)

	(60%)	(38%)	(36%)	(47%)	
All Foreign Countries	88	90	46	110	334

Anticipated number of returning Canadian PhDs to be hired by Ontario universities in each year of the projection period assuming a 60% return rate and Ontario university shares as shown

	.95	.73	.52	.52	
All Foreign Countries	50	39	15	34	128

Source: Max von Zur-Muehlen, The PhD Dilemma in Canada, Economic Council of Canada, 1971.

FIGURE 22

excess (8% and 16% respectively) and in Social Sciences there will be a slight shortage. Also shown in Figures 25 and 26 are two other estimates which assume larger PhD percentages in the new staff hired by the universities as well as a larger Canadian component of the PhD staff hired. Under these assumptions the overall PhD surplus could be negligible with a significant excess in Humanities and a significant shortage in Social Sciences (Figure 25) or there could be a PhD shortage overall with a large deficit in Social Sciences (Figure 26). It should be emphasized that the Biological Sciences category excludes Medicine, Dentistry, Nursing and the para-medical disciplines and the Social Science category excludes Education.

If either of the patterns of Figure 24 or 25 should come to pass the large projected surplus in Humanities could represent a major problem because of the magnitude of the oversupply and because virtually all of the PhD supply in this category has traditionally been absorbed by universities. It should be noted however, that even within this category there are disciplines still in short supply (Canadian studies, francophone programmes, etc.). The analysis suggests that this discipline group should be examined at a lower level of detail. In the other discipline groupings there is always the likelihood of one of the other sectors absorbing small surpluses as they appear.

Our analyses also show that the recent drop in PhD enrolments will result in a peak in PhD graduations in 1973-74 with very significant decreases in all discipline groupings in the following years. This should be noted because the last five years of the seventies could see us moving again into a deficit position to which we could apply a retained surplus.

Readers may disagree with some of the many assumptions that have been made in the paper and may want to make different assumptions and evaluate them for their effects. Because of this and because of the laborious nature of the computations involved, we have constructed a simple computer model which is capable of quickly evaluating any combination of parametric values one could care to give to the variables involved provided that the basic structure of the supply and demand model described above is considered acceptable.

It should be noted that in the foregoing analysis we have assumed that there will be no significant increase in the number of post-doctoral fellowships granted during the projection period. Therefore, the number of PhDs obtaining fellowships will be roughly balanced by those completing them and the existence of PDF's in the system may be ignored.

The supply of academic staff with PhDs available for the Ontario university system (1971-72 to 1976-77)

(Based on the COU estimate)

Year	Humanities	Social Sciences	Biological Sciences	Physical Sciences	Total
1971-72	154	102	52	195	502
1972-73	219	153	55	219	647
1973-74	247	190	60	224	722
1974-75	232	222	52	178	684
1975-76	196	192	44	161	593
1976-77	152	112	53	196	513

(Based on the university estimate)

1971-72	155	138	60	165	518
1972-73	169	159	61	174	562
1973-74	186	172	64	175	597
1974-75	199	187	68	174	628
1975-76	204	199	71	176	649
1976-77	210	209	79	169	667

(Based on the E.C. estimate)

1971-72	143	135	59	170	507
1972-73	155	147	65	187	554
1973-74	171	164	73	210	617
1974-75	185	178	79	230	673
1975-76	205	199	89	260	753
1976-77	226	220	99	290	834

FIGURE 23

PATTERN 1

The surplus (deficit) of PhDs available to the Ontario university system based on COU's supply estimate and the OISE demand estimate (incremental)

Year	Humanities	Social Sciences	Biological Sciences	Physical Sciences	Total
1971-72	53	(49)	9	47	60
1972-73	112	(8)	10	65	178
1973-74	124	4	9	47	183
1974-75	108	33	2	4	147
1975-76	67	(5)	(7)	(15)	40
1976-77	19	(93)	1	17	(57)
Surplus Total 1971-76	483	(118)	24	165	551
Demand Total 1972-77	720	1089	293	1008	3110
Surplus as a % of demand	67%	(11%)	8%	16%	18%
Parameter values					
a) 20.0:1 incremental student/staff ratio					
b) 3.5% attrition replacement rate					
c) PhD Increment (%)	60%	65%	90%	95%	73%*
d) Canadian Increment (%)	60%	70%	80%	70%	68%*
e) Ontario university employment (%)	67%	58%	34%	38%	47%
f) A 60% return rate for Canadian PhDs					

*Based on weighted 1971-72 demand projections.

FIGURE 24

PATTERN 2

The surplus (deficit) of PhDs available to the Ontario university system based on COU's supply estimate and the OISE demand estimate (incremental)

Year	Humanities	Social Sciences	Biological Sciences	Physical Sciences	Total
1971-72	17	(72)	9	37	(10)
1972-73	73	(33)	10	54	104
1973-74	79	(25)	9	34	97
1974-75	63	4	2	(8)	60
1975-76	20	(35)	(7)	(28)	(50)
1976-77	(30)	(124)	1	4	(149)
Surplus Total 1971-76	222	(285)	24	93	52
Demand Total 1972-77	980	1256	293	1080	3609
Surplus as a % of demand	23%	(23%)	8%	9%	1%
Parameter values					
a) 20.0:1 incremental student/staff ratio					
b) 3.5% attrition replacement rate					
c) PhD Increment (%)	70%	70%	90%	95%	78%*
d) Canadian Increment (%)	70%	75%	80%	75%	74%*
e) Ontario university employment (%)	67%	58%	34%	38%	47%
f) A 60% return rate for Canadian PhDs					

*Based on weighted 1971-72 demand projections

FIGURE 25

PATTERN 3

The surplus (deficit) of PhDs available to the Ontario university system based on COU's supply estimate and the OISE demand estimate (incremental)

Year	Humanities	Social Sciences	Biological Sciences	Physical Sciences	Total
1971-72	(26)	(110)	9	26	(101)
1972-73	28	(74)	10	43	7
1973-74	27	(72)	9	22	(14)
1974-75	11	(44)	2	(20)	(52)
1975-76	(34)	(85)	(7)	(40)	(166)
1976-77	(86)	(176)	1	(9)	(270)
Surplus Total 1971-76	(80)	(561)	24	22	(596)
Demand Total 1972-77	1280	1531	293	1152	4256
Surplus as a % of demand	(6%)	(37%)	8%	2%	(14%)
Parameter values					
a) 20.0:1 incremental student/staff ratio					
b) 3.5% attrition replacement rate					
c) PhD Increment (%)	80%	80%	90%	95%	84%*
d) Canadian Increment (%)	80%	80%	80%	80%	80%*
e) Ontario university employment (%)	67%	58%	34%	38%	47%
f) A 60% return rate for Canadian PhDs					

*Based on weighted 1971-72 demand projections.

FIGURE 26

Addendum 1

A DOCUMENTATION OF THE DIFFERENCES BETWEEN THE DUA, DBS AND OCGS DISCIPLINE GROUPINGS

It is by now evident that the greatest obstacles to competent higher educational research in Ontario are firstly, a lamentable lack of basic data and secondly, incompatible and less than judicious choices of data taxonomies, as the discussion that follows will illustrate.

We shall have to reference at various points in the analysis information collected and reported by the Department of University Affairs of Ontario, the Dominion Bureau of Statistics, and the Ontario Council on Graduate Studies. Unfortunately, the classifications of disciplines or fields used by the three above-mentioned organizations differ significantly. Since in some cases data are only available on four major discipline groupings, we have been forced to examine the differences between these discipline groupings in order to obtain some idea of the degree of incompatibility involved. We shall use the DBS classification system as a base and document all of the differences that exist between it and the other two classification systems.

Figure 27 shows the differences between the DBS and OCGS classifications when a comparison is made at the levels of the major discipline groupings shown. The third and fifth columns give the disciplines or fields which are included in one of the classifications but not in the other. For example, the DBS Pure Humanities and Applied Humanities group includes Library Science which is not included in either of the two OCGS Humanities groups. On the other hand, the two OCGS Humanities groups include History which is absent from the two DBS Humanities groups.

It will be seen that all of the additional inclusions in both classification schemes, can be paired off except Extension Education, Textiles, Clothing and Design, Optometry, and Physical and Occupational Therapy.

It is our intention to eliminate certain disciplines from this analysis because they are better treated separately or because they tend to distort the results. Such fields are Medicine, Dentistry, Nursing, P.O.T.S., Education and Optometry. This being the case the fact that Extension Education does not pair off becomes irrelevant since all Education will be excluded anyway. We do not quite know what to do with Textiles, Clothing and Design, but it seems likely that its enrolment is negligible and therefore we shall ignore it. The remaining sources of non-comparability are Library Science, Secretarial Science, History, Soil Science, Urban and Regional Planning, Biochemistry and Biophysics.

COMPARISON OF DBS AND OCGS DISCIPLINE GROUPINGS

Discipline Group for Academic Staff Study	DBS Discipline Groups	Additional Inclusions in DBS	OCGS Discipline Groups	Additional Inclusions in OCGS
Humanities	Pure Humanities Applied Humanities	Library Science	Humanities (Lang. & Lit.) Humanities (History, Philosophy, Arts)	History
Social Science	Pure Social Science Applied Social Science	History	Social Science (General) Social Science (Regional, Geographic, Planning) Education Business Other	Urban and Regional Planning Extension, Education Nursing, Library Science
Biological Sciences	Pure Biological Science Applied Biological Science	Soil Science Nursing Optometry P.O.T.S.	Life Sciences Health Sciences	Biochemistry Biophysics
Physical Sciences	Pure Physical Science Applied Physical Science	Urban and Regional Planning, Biophysics Biochemistry	Physical Science Mathematical Science Engineering	Soil Science Textiles Clothing & Design

FIGURE 27

It was felt at first that the next step should be to choose a base year and derive a set of simple correction factors which may be applied to the OCGS data to make them approximately comparable with DBS data. This could be done by obtaining the number of full-time undergraduate students enrolled in the additional fields in each major grouping and computing a net percentage or factor to be applied to one set of data to make it comparable with the other. However, for History, Biophysics, and Biochemistry this cannot be done because DBS only reports enrolment by faculty, i.e., under Arts, Science or Arts, and Science. Furthermore, an inspection of the remaining additional disciplines will show that their enrolments are quite small, totalling less than 500 students. This leaves History, Biochemistry and Biophysics as the major sources of incompatibility between the DBS and OCGS discipline groupings.

Figure 28 shows the differences between the DBS and DUA classifications when a comparison is made at the levels of the major discipline groupings shown. The disciplines or discipline areas which are included in one of the classifications but not in the other are given in the third and fifth columns. It can easily be seen that there are three very serious differences between the two classification schemes. Firstly, the DUA classification includes all fields of Pure Social Sciences, i.e., Anthropology, Economics, Political Science, Geography, History, Psychology and Sociology under Humanities-Pure. Secondly, the University of Toronto enrols all of its students in undergraduate arts and science programmes in one faculty called the Faculty of Arts and Science and all of these students are lumped together under Humanities-Pure. This problem also occurs with the DBS classification. Thirdly, the DUA classification does not differentiate between Biological Sciences-Pure and Physical Sciences-Pure so that all fields or disciplines of Biological Sciences-Pure are included under Physical Sciences in our comparison. The other differences relating to Hygiene and Public Health, Optometry and Pre-medicine are minor.

The differences described above make it impossible to use DUA enrolment data even at the gross level of four major discipline groupings. Fortunately, DUA, in reporting baccalaureate and doctoral degrees granted, uses eight discipline groupings, i.e., Biological and Physical Sciences-Pure is split into Biological Sciences-Pure and Physical Sciences-Pure and an extra category Social Sciences-Pure is employed. There is no information given as to the criteria for placing degrees in these categories but since there is reasonable agreement with DBS data at the level of four major discipline groupings, we shall assume that some compatibility exists between DBS and DUA as far as the reporting of degrees granted is concerned.

One more aspect of the DBS enrolment data classifications must be described. DBS does not classify student enrolment by the major discipline groupings described above. Instead, all enrolments are grouped into faculties which are listed in Figure 29. Also shown in Figure 29 are the discipline groupings into which these faculty enrolments have been mapped as well as those faculties which have been excluded. It may

COMPARISONS OF DBS AND DCU DISCIPLINE GROUPINGS

Discipline Group for Academic Staff Study	DBS Discipline Groups	Additional Inclusions in DBS	DCU Discipline Groups	Additional Inclusions in DCU
Humanities	Pure Humanities		Humanities-Pure Humanities-Applied	All fields of Pure Social Science as well as all Arts and Science students at the University of Toronto
Social Sciences	Pure Social Science Applied Social Science	All fields of Pure Social Science	Social Sciences-Applied	Hygiene and Public Health
Biological Sciences	Pure Biological Science Applied Biological Science	All fields of Pure Biological Science such as Botany and Zoology Also Hygiene and Public Health and Optometry	Biological Sciences-Applied	
Physical Sciences	Pure Physical Science Applied Physical Science		Biological and Physical Sciences-Pure, Physical Sciences-Applied	All fields of Pure Biological Science such as Botany and Zoology. Also Pre-Medicine

FIGURE 28

DBS ENROLMENT CLASSIFICATIONS

Faculty	Discipline Groupings
Arts	Not relevant
Pure Science	Not relevant
Agriculture	Biological Science
Architecture	Physical Science
Commerce & Business Admin.	Social Science
Dental Studies	Excluded
Education	Excluded
Engineering, Applied Science	Physical Science
Fine & Applied Arts	Humanities
Forestry	Biological Science
Household Science	Social Science
Journalism	Humanities
Law	Social Science
Library Science	Humanities
Medical Studies	Excluded
Medical Technology	Excluded
Music	Humanities
Nursing	Excluded
Optometry	Excluded
Pharmacy	Biological Science
Phys., Health Education	Social Science
Phys., Occ. Therapy	Excluded
Religious Education	Excluded
Secretarial Science	Social Science
Social Work	Social Science
Theology	Humanities
Veterinary Medicine	Biological Science
Others	Excluded
Miscellaneous	Excluded
Unclassified	Excluded

FIGURE 29

be seen that the Arts and Pure Science faculties must be broken out in some way if we are to obtain a proper distribution into Humanities, Social Sciences, Biological Sciences and Physical Sciences. We did attempt a rather involved method for splitting the DBS and DUA student enrolments into the four major discipline groupings but without success. Suffice to say that ultimately we became convinced that the demand for academic staff could only be projected in toto and then broken out into the four major discipline groupings on the basis of an historical distribution of staff or a subjectively modified distribution thereof.

The institutions included in the study

For this study, the following institutions were included:

a) All provincially assisted universities including their federated and affiliated colleges where such colleges exist;

b) All university-affiliated Theological Colleges;

c) Regis College and Waterloo Lutheran University.

The following institutions listed by DBS and/or DUA were specifically excluded:

Anglican United College, Canadian Memorial Chiropractic College, Ontario Bible College, Royal Military College and the Ontario College of Art.

The enrolments and staff included in the study

For this study all enrolments in the following programmes were excluded:

Medicine, Dentistry, Nursing, Physical and Occupational Therapy, Optometry, Hygiene and Public Health and Education.

In addition, all staff in the corresponding set of departments were excluded.

Finally, all Medical interns, Preliminary year students and Diploma and Technology students were excluded from all student enrolments.

Appendix 3

Employment of Students Awarded PhDs in 1970-71
in Canada

Ontario Council on Graduate Studies,
November 1971.

This paper presents the figures on immediate post-graduation employment of PhDs in 1970-71 and considers briefly some trends. The compilation was done under the aegis of the Canadian Association of Graduate Schools and the Ontario Council on Graduate Studies. It follows up previous work confined to Ontario and illustrates the high degree of similarity between the Ontario figures and those for Canada at large.

The number reported in Ontario as "unemployed" is 40 students, in Canada 72 (Table 7). Because one university outside Ontario has not reported we might expect the "unemployed" number to reach about 80 for Canada. This is 6% of those graduating. The term "unemployed" must however be understood. In most cases, it means that the student was unable to report definite employment at the time he submitted his thesis. He may have obtained employment since then. The Ontario 1964-69 survey is not comparable in this respect, since what was reported there was the graduate's first employment and the data were obtained months or years after graduation; consequently those shown as "unemployed" in the 1964-69 survey are those who did not wish immediate employment, including some housewives, who reported as "unemployed".

It has been suggested that graduates are shifting to other than the traditional forms of employment. Table 7 shows that the percentage of Ontario graduates entering university teaching immediately has fallen by perhaps 7% over a three or four year period. The fraction entering industrial positions has also decreased. There is no marked change in the total percentage obtaining research fellowships or government positions. There is an increased proportion in "other" employment. This category includes college and school teaching, self-employed consultants, certain business opportunities, etc. In general then, only the two categories "other" and "unemployed" have a larger fraction of the graduates this year.

Let us examine the separate discipline groupings. Table 1 illustrates the situation in Humanities. The numbers here are small, only 162 in the Canada-wide sample, but insofar as statistics are meaningful, there appears to be some greater diversity in the positions taken up. Whereas in the 1964-69 period only 6% of the Ontarians were in other than university teaching, this year 16% are. We see here also some unemployment (as defined in this study) -- a total of 5 persons in Ontario (only 10 in all of Canada).

Table 2 shows that there is virtually no unemployment for Social Science PhDs. Four people in Canada are so categorized, but it is unlikely that their situations are connected with difficulties of finding positions. In this field, we may note that a smaller fraction are entering university teaching and industry directly, and that the opportunities for research fellowships are increasing noticeably. It may be that we see here the beginnings of a career pattern somewhat like that of the scientists, so many of whom spend a few years as research fellows before seeking more "permanent" jobs.

Table 3 and Table 5 for the Physical and Life Sciences show the same pattern -- marked decrease in immediate positions in university teaching, industry and government, compensated partly by a small increase in research fellowships, "other" employment, and entries in the "unemployed" column. Some of this "unemployment" may be real, at least temporarily. It should be noted that, contrary to some current statements, the research fellowships should not be interpreted as a holding operation. As the data from 1964-69 show, the career pattern of scientists with certain goals contains a few years as a research fellow, and over that era 38% of PhDs became research fellows. This year the number is 44% which is an increase of 6% -- or 12 people. It should also be observed that the NRC policy of strengthening Canadian research groups with research fellows from Canadian universities has had obvious effects -- from 1964-69 about 25% of the research fellows were in Canada, last year about 44% were, in the current year, with the same total number of fellows as last year, 60% will be in Canada.

It may also be observed that the fraction of graduates entering Canadian industry from the physical sciences is constant (8%). The drop in industrial employment is in foreign (presumably U.S.) opportunities.

The picture for engineering in Table 4 shows a remarkable and disquieting pattern. As our engineering schools have entered a phase of slower growth, the university employment has fallen. But industrial employment has not grown -- it too has decreased. The 197 graduating in Ontario in 1964-69 obtained 33 Canadian industrial positions; on the same ratio, the 111 graduating in Ontario this year would have obtained 19 positions in Canadian industry, but in fact there were only 13. It is noted that the "unemployment" rate for PhD engineers is the same 8% as it is for scientists and humanists, but surely there is no "real" unemployment here. Of much greater interest is the fact that the holders of research fellowships have increased from 5% to 21% of the graduates. In engineering this is a drastic change in pattern and may be a warning of difficulties to come.

It should be mentioned that in the sciences where research fellowships are a standard part of the educational system, or better, perhaps, a standard part of the maturing process of the young scholar, these figures do not tell the whole story. We need similar tables for employment immediately following two or three years of research fellowship. The report of our five year study of employment of Ontario PhDs contains such data, and we know that in that period the majority went from research fellowships into university teaching and government laboratories. We believe these avenues may be restricted now to a noticeable extent.

Much can be gained if we have more highly educated people in "other" employment, whether it be entrepreneurial, business, non-university teaching, or the civil service.

What of the future, and of responses to the general belief that there is an over-production problem? One danger is a drop in new enrolments (not just a drop in the rate of growth, but an actual decrease in numbers), followed in a year or two by a belief that jobs are going to be easy to find again, with a resultant increase in enrolment -- in short a periodic fluctuation possibly involving increasing extremes.

The most disturbing thing is that in Ontario, presumably in part due to students' perceptions of the economic situation, and in part due to the drastic cut in various forms of student support, it is clear that the master's enrolment in 1971-72 is less than in 1970-71 in every field except the Medical Sciences. The decreases in Humanities and Social Sciences are 17% and 9% respectively. Careful analysis of where these decreases occur, and a knowledge that the full impact of the support reduction is not yet apparent since it does not apply to students "in course", lead to the conclusion that the PhD intake in these subjects will be down very markedly for 1972-73 unless there is a carefully devised student support programme.

Notes to Tables

1. The column 1964-69 includes all Ontario PhDs who graduated from the fall convocations of 1964 to the spring convocation of 1969, inclusive. Likewise the 1969-70 and 1970-71 Ontario numbers refer to academic years, fall through spring.

2. The column Canada 1970-71 is an almost complete sample of those graduating in convocations from fall 1970 through spring 1971 inclusive. One university with PhD graduates has not reported (Laval) and the report from McGill is not complete. Also in one or two cases data from one of the convocations was not available. While a complete return would alter the number of persons in each category, it is not expected that the percentage would change appreciably.

Table 1

IMMEDIATE POST-GRADUATION EMPLOYMENT OF CANADIAN PH.D.s

HUMANITIES

	Canada 1970-71		Ontario 1970-71		Ontario 1969-70		Ontario 1964-69	
	Number	%	Number	%	Number	%	Number	%
OCCUPATION								
UNIVERSITY TEACHING								
In Canada	109	67	75	67	66	73	124	69
Elsewhere	25	15	19	17	13	14	45	25
Total	134	83	94	84	79	88	169	94
INDUSTRY								
In Canada	0	0	0	0	0	0	1	1
Elsewhere	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	1	1
RESEARCH FELLOWSHIP								
In Canada	4	2	2	2	0	0	0	0
Elsewhere	0	0	0	0	0	0	2	1
Total	4	2	2	2	0	0	2	1
PRIVATE RESEARCH INSTITUTE								
In Canada	2	1	1	0	0	0	0	0
Elsewhere	1	1	0	1	0	0	1	1
Total	3	2	1	1	0	0	1	1
GOVERNMENT								
In Canada	3	2	2	2	1	1	2	1
Elsewhere	0	0	0	0	2	2	0	0
Total	3	2	2	2	3	3	2	1
UNEMPLOYED								
In Canada	9	6	5	4	3	3	1	1
Elsewhere	1	1	0	0	2	2	0	0
Total	10	7	5	4	5	6	1	1
OTHER								
In Canada	8	5	8	7	3	3	3	1
Elsewhere	0	0	0	0	0	0	1	1
Total	8	5	8	7	3	3	4	2
TOTAL	162		112		90		180	
NOT KNOWN	5		2		3		53	

Table 2

IMMEDIATE POST-GRADUATION EMPLOYMENT OF CANADIAN PH.D.s

SOCIAL SCIENCES (EDUCATION OMITTED)

	Canada 1970-71		Ontario 1970-71		Ontario 1969-70		Ontario 1964-69	
	Number	%	Number	%	Number	%	Number	%
OCCUPATION								
UNIVERSITY TEACHING								
In Canada	106	54	53	43	44	42	118	54
Elsewhere	30	15	23	19	22	21	36	16
Total	136	69	76	62	66	63	154	70
INDUSTRY								
In Canada	2	1	2	2	2	2	10	5
Elsewhere	1	1	0	0	0	0	8	3
Total	3	2	2	2	2	2	18	8
RESEARCH FELLOWSHIP								
In Canada	9	4	7	6	4	4	3	1
Elsewhere	5	2	5	4	3	3	5	2
Total	14	6	12	10	7	7	8	4
PRIVATE RESEARCH INSTITUTE								
In Canada	3	2	1	1	7	7	2	1
Elsewhere	2	1	1	1	0	0	0	0
Total	5	3	2	2	7	7	2	1
GOVERNMENT								
In Canada	16	8	14	11	11	10	24	11
Elsewhere	1	1	1	1	4	4	1	0
Total	17	9	15	12	15	14	25	11
UNEMPLOYED								
In Canada	4	2	2	2	3	3	0	0
Elsewhere	0	0	0	0	0	0	1	0
Total	4	2	2	2	3	3	1	0
OTHER								
In Canada	15	8	12	10	2	2	12	6
Elsewhere	3	2	2	1	3	3	1	0
Total	18	10	14	11	5	5	13	6
TOTAL	197		123		105		221	
NOT KNOWN	8		4		5		39	

Table 3

IMMEDIATE POST-GRADUATION EMPLOYMENT OF CANADIAN PH.D.s
PHYSICAL SCIENCES (INCLUDING MATHEMATICS)

	Canada 1970-71		Ontario 1970-71		Ontario 1969-70		Ontario 1964-69	
	Number	%	Number	%	Number	%	Number	%
OCCUPATION								
UNIVERSITY TEACHING								
In Canada	62	13	30	13	28	13	120	20
Elsewhere	46	10	23	10	16	8	86	14
Total	108	23	53	24	44	21	206	34
INDUSTRY								
In Canada	33	7	19	8	18	9	51	8
Elsewhere	20	4	9	4	15	7	51	8
Total	53	11	28	12	33	16	102	17
RESEARCH FELLOWSHIP								
In Canada	113	25	64	29	40	19	53	9
Elsewhere	77	17	31	14	53	25	182	29
Total	190	42	95	42	93	45	235	38
PRIVATE RESEARCH INSTITUTE								
In Canada	2	1	0	0	4	2	0	0
Elsewhere	4	1	4	2	6	3	3	0
Total	6	2	4	2	10	5	3	0
GOVERNMENT								
In Canada	31	6	13	6	15	7	37	6
Elsewhere	11	1	3	1	5	2	18	3
Total	42	8	16	7	20	10	55	9
UNEMPLOYED								
In Canada	28	6	14	6	2	1	0	0
Elsewhere	4	1	3	1	0	0	0	0
Total	32	7	17	8	2	1	0	0
OTHER								
In Canada	22	5	7	3	4	2	7	1
Elsewhere	8	2	4	2	2	1	3	0
Total	30	7	11	5	6	3	10	2
TOTAL	461		224		208		611	
NOT KNOWN	9		2		6		117	

Table 4

IMMEDIATE POST-GRADUATION EMPLOYMENT OF CANADIAN PH.D.s

ENGINEERING

	Canada 1970-71		Ontario 1970-71		Ontario 1969-70		Ontario 1964-69	
	Number	%	Number	%	Number	%	Number	%
OCCUPATION								
UNIVERSITY TEACHING								
In Canada	46	23	24	22	25	25	66	32
Elsewhere	21	11	13	12	8	8	29	14
Total	67	34	37	33	33	33	95	46
INDUSTRY								
In Canada	25	13	13	12	18	18	44	21
Elsewhere	19	10	14	13	3	3	17	8
Total	44	23	27	24	21	21	61	29
RESEARCH FELLOWSHIP								
In Canada	36	18	19	17	19	19	14	7
Elsewhere	6	3	4	4	6	6	9	4
Total	42	21	23	21	25	25	23	11
PRIVATE RESEARCH INSTITUTE								
In Canada	1	1	1	1	3	3	4	2
Elsewhere	1	1	0	0	4	4	1	0
Total	2	1	1	1	7	7	5	2
GOVERNMENT								
In Canada	18	9	8	7	7	7	14	7
Elsewhere	3	1	0	0	4	4	3	1
Total	21	10	8	7	11	11	17	8
UNEMPLOYED								
In Canada	13	7	9	8	1	1	0	0
Elsewhere	0	0	0	0	1	1	1	0
Total	13	7	9	8	2	2	1	0
OTHER								
In Canada	6	3	5	5	0	0	2	1
Elsewhere	3	1	1	1	0	0	4	2
Total	9	4	6	5	0	0	6	3
TOTAL	198		111		99		208	
NOT KNOWN	4		2		3		23	

Table 5

IMMEDIATE POST-GRADUATION EMPLOYMENT OF CANADIAN PH.D.s

LIFE SCIENCES

	Canada 1970-71		Ontario 1970-71		Ontario 1969-70		Ontario 1964-69	
	Number	%	Number	%	Number	%	Number	%
OCCUPATION								
UNIVERSITY TEACHING								
In Canada	41	20	15	17	16	17	50	18
Elsewhere	18	9	4	5	11	11	44	16
Total	59	29	19	22	27	28	94	34
INDUSTRY								
In Canada	9	4	3	3	2	2	6	2
Elsewhere	2	1	1	1	0	0	3	1
Total	11	5	4	5	2	2	9	3
RESEARCH FELLOWSHIP								
In Canada	42	20	17	20	20	21	29	11
Elsewhere	41	20	24	28	24	25	74	27
Total	83	40	41	48	44	46	103	38
PRIVATE RESEARCH INSTITUTE								
In Canada	3	1	2	2	3	3	8	3
Elsewhere	4	2	3	3	1	1	7	2
Total	7	3	5	6	4	4	15	5
GOVERNMENT								
In Canada	21	10	6	7	7	7	30	11
Elsewhere	4	2	1	1	5	5	6	2
Total	25	12	7	8	12	13	36	13
UNEMPLOYED								
In Canada	10	5	5	6	1	1	0	0
Elsewhere	3	1	1	1	2	2	3	1
Total	13	6	6	7	3	3	3	1
OTHER								
In Canada	5	3	3	3	3	3	11	4
Elsewhere	3	1	1	1	1	1	3	1
Total	8	4	4	5	4	4	14	5
TOTAL	206		86		96		274	
NOT KNOWN	3		0		1		37	

Table 6

IMMEDIATE POST-GRADUATION EMPLOYMENT OF CANADIAN PH.D.s

HEALTH SCIENCES

	Canada 1970-71		Ontario 1970-71		Ontario 1969-70		Ontario 1964-69	
	Number	%	Number	%	Number	%	Number	%
OCCUPATION								
UNIVERSITY TEACHING								
In Canada	16	18	8	19				
Elsewhere	4	4	3	7				
Total	20	22	11	26				
INDUSTRY								
In Canada	4	5	0	0				
Elsewhere	0	0	1	2				
Total	4	5	1	2				
RESEARCH FELLOWSHIP								
In Canada	21	23	8	19				
Elsewhere	22	24	9	21				
Total	43	48	17	40				
PRIVATE RESEARCH INSTITUTE								
In Canada	0	0	0	0				
Elsewhere	2	2	1	2				
Total	2	2	1	2				
GOVERNMENT								
In Canada	10	11	6	14				
Elsewhere	3	3	2	5				
Total	13	14	8	19				
UNEMPLOYED								
In Canada	0	0	0	0				
Elsewhere	0	0	0	0				
Total	0	0	0	0				
OTHER								
In Canada	7	8	3	7				
Elsewhere	1	1	1	2				
Total	8	9	4	10				
TOTAL	90		42					
NOT KNOWN	0		0					

Table 7

IMMEDIATE POST-GRADUATION EMPLOYMENT OF CANADIAN PH.D.s

TOTAL

	Canada 1970-71*		Ontario 1970-71		Ontario 1969-70		#Ontario 1964-69	
	Number	%	Number	%	Number	%	Number	%
OCCUPATION								
UNIVERSITY TEACHING								
In Canada	380	29	205	30	183	30	489	32
Elsewhere	144	11	85	12	74	12	248	16
Total	524	40	290	42	257	42	737	48
INDUSTRY								
In Canada	73	6	37	5	40	7	112	7
Elsewhere	42	3	25	4	18	3	79	5
Total	115	9	62	9	58	10	191	13
RESEARCH FELLOWSHIP								
In Canada	225	17	117	17	83	14	99	7
Elsewhere	151	11	73	10	86	14	272	18
Total	376	28	190	27	169	28	371	25
PRIVATE RESEARCH INSTITUTE								
In Canada	11	1	5	1	17	3	14	1
Elsewhere	14	1	9	1	11	2	12	1
Total	25	2	14	2	28	5	26	2
GOVERNMENT								
In Canada	99	7	49	7	41	7	108	7
Elsewhere	22	2	7	1	20	3	28	2
Total	121	9	56	8	61	10	136	9
UNEMPLOYED								
In Canada	64	4	35	5	10	2	1	0
Elsewhere	8	1	4	1	5	1	5	0
Total	72	5	39	6	15	2	6	0
OTHER								
In Canada	63	5	38	5	12	2	36	2
Elsewhere	18	1	9	1	6	1	14	1
Total	81	6	47	7	18	3	50	3
TOTAL	1314		698		606		1517	
NOT KNOWN	29		10		18		289	

* Excluding Laval

\# Includes other disciplines not already designated.